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A PROGRESS REPORT

RESEARCH ON LONG-TERM TESTING OF GROUTS USED UNDERGROUND FOR CONTROL OF BRINE IN POTASH MINES

BY

M.D. Haug, A.A. Al-Manaseer, and L. Wong

FOR

CENTRAL CANADA POTASH

A CO-OPERATIVE RESEARCH PROGRAM WITH THE DEPARTMENT OF CIVIL ENGINEERING, UNIVERSITY OF SASKATCHEWAN

JANUARY, 1990

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MICROMEDIA

1.0 EXECUTIVE SUMMARY

This report summarizes the research conducted in 1989 on grouts used to control brine in potash mines. The grout research program is designed to evaluate the long-term performance and suitability of cement and chemical grouts in high pressure brine environments. This program was initiated in 1987 by the Saskatchewan Potash Producers Association (SPPA) under the guidance of Central Canada Potash.

Samples of these grouts were prepared and submerged in brine under different confining pressures. These different confining pressures were chosen to evaluate the effect of high sample confining pressures on performance of these grouts in brine environments. A laboratory testing program was established to evaluate these grouts for weight loss, strength etc. after increasing periods of brine exposure.

The first year of this research program concentrated on the development of the testing program, and the design and construction of the testing equipment. Test specimens were also prepared and long term tests initiated. 1989 was the second year of this research program. Samples were removed from the containers and tested three times during the year (i.e. at 40, 90 and 365 days). At each of these times the cement based grouts were measured to determine if any change in volume had taken place. Secondly, sonic readings were taken to evaluate possible cracking and estimate strength. Selected samples were also subjected to tensile and compressive strength tests. Samples were also examined under a scanning electron microscope to observe apparent changes in structure. The chemical grout based samples were visually inspected, measured for changes in dimension and weighed.

A preliminary analysis of test results shows that some of the grouts performed significantly better than others. If this preliminary observation is confirmed by the detailed analysis to be conducted in 1990, it may be possible to eliminate some of the grouts selected and include others, or focus on the ones showing the most potential.

2.0 INTRODUCTION

Brine control involves the sealing of brine inflows which originate in salt water bearing portions of the Dawson Bay Formation. This fractured limestone formation is located above the mining horizon and extends throughout much of the Province. Excavations into underground salt anomalies or subsidence resulting from the mining of potash may result in the rapid inflow of saturated brine into the mine workings from this formation. Grouting into this high pressure brine environment has been one of the few techniques which has had success in either controlling or slowing the rate of these inflows. Thus, it is important to understand how different grouts will perform in this environment. In addition, since the potential life of these mines may be many tens of years, it is also important to understand how these grouts will perform under extended periods of service.

To evaluate the long-term performance of grouts in a brine environment a 5 year test program was established. This program was designed to evaluate the performance of different chemical and cement based grouts confined at pressures of 0, 3.4, and 6.9 MPa (0, 500, and 1000 psi respectively). The cement based grouts chosen for this program included brine, Type 30 cement, fly ash, and various types of superplasticizer. A sodium bentonite was also used in one

of the grout samples. The chemical grouts included AC-400 and AV-100. Details of the preparation of these grouts is contained in the January, 1989 Progress Report.

The test samples were contained in specially constructed pressure vessels. These vessels were designed to provide a brine environment for the samples. Special features were also added to ensure that chemical reactions did not take place between the different grout material being contained. This was done with flexible rubber partitions and by using separate vessels for the cement and chemical based grouts. Details of this test equipment was also presented in the January 1989 progress report.

This report presents the results of the tests conducted during 1989. It identifies the chemical composition, and describes the physical properties of the materials, from which the grouts are composed. Physical properties of these grouts (the compressive strength, tensile strength, modulus of elasticity, color changes, and weight losses) are also described. A resonant frequency test was used to determine the overall quality characteristics of the cement grout and to observe any internal deterioration due to brine influence. In addition, a scanning electron microscope with electron probe x-ray micro-analyzer was used to study the combined effect of brine and fly ash on the microstructure of the cement grout.

Analysis of the results the tests conducted during 1989 will be performed in 1990, and these results will be reported in the July, 1990 progress report.

3.0 TEST MATERIALS

3.1 Cement Grouts

Four standard type grout mixes were investigated, two of these contained 60% Type III cement, and 40% lignite Saskatchewan fly ash, while the other two contained 100% Type III cement. All mixes were prepared with brine fluid and have a brine/(cement + fly ash) ratio of 1:1. The chemical composition and the physical tests of the cement and the fly ash are given in Tables 1 and 2.

3.1.1 Type 30 Cement Grout Mix with Bentonite

In addition to the standard type of grout mixes, a special trial cement grout with high water cement ratio and containing bentonite was mixed during March, 1989. The objective of mixing this grout was to study the effect of high water cement ratio and bentonite on the behavior of cement grout. The mix proportion of this grout was as follows:

- Type 30 Cement 40 kg (88 lbs)
- Avongel Bentonite 3.64 kg (8 lbs)
- Brine 436.36 kg (960 lbs)

Two batches of the above grouts were mixed on 28 March, 1989. The first batch of grout was mixed for five minutes. The cement and bentonite particle started to settle to the bottom of the cardboard cylinder right after mixing. The second batch was mixed for 20 minutes instead of 5 minutes. The cement and bentonite particle settled in the same manner as the first batch.

3.2 Chemical Grouts

Two types of chemical grouts were investigated: the Avanti AV-100, and the Geochem AC-400. These grouts were mixed underground in the mine at a temperature of approximately 30°C. The mixing procedure was designed so that the grouts would set in 3 hours. The composition of the Avanti AV-100 grout was:

22.7 Liters (5 gallons) of brine

2.3 kg (5 lb.) of AV-100 (powder) Acrylamide

105 ml (6.4 in^3) of AV-101 Catalyst T.E.A. Triethyl amine

0.1 kg (0.25 lb.) of Ammonium Persulfate (AP) in 200 ml (12.2 in^3) of fresh water

54 g (0.1 lb.) of Potassium Ferricyanice (KFe) in 200 ml (12.2 in^3) of hot fresh water (the liquid was kept free from light sources)

The composition of the Geochem AC-400 grout was:

15.4 Liters (3.4 gallons) of brine

6.1 Liters (1.35 gallons) of AC-400 (liquid) Acylamide

105 ml (6.4 in^3) of AV-101 Catalyst T.E.A.

0.1 kg (0.25 lb.) of Ammonium Persulfate (AP) in 200 ml (12.2 in^3) of fresh water

54 g (0.1 lb.) of Potassium Ferricyanide (KFe) in 200 ml (12.2 in^3) of hot fresh water (the liquid was kept free from light sources)

3.3 Brine

The brine chemical composition is given in Table 3.

4.0 SAMPLE PREPARATION AND TESTING

Cement and chemical group specimens were prepared and submerged in brine under different confining pressures. Three levels of confining pressures at 0, 3.4, and 6.90 MPa (0, 500, 1000 psi) have been selected. The confining pressure was required to simulate different mine conditions. A detailed description of grout preparation, curing, and loading was provided in the 1989 annual report.

5.0 PRESENTATION OF THE TEST RESULTS

5.1 Cement Based Grouts

Figure 1 is a photograph showing the cement based grouts removed for testing on November 24, 1989. The dark colored samples were composed of fly ash. The shorter samples contained no fly ash. Bleeding accounted for the loss of height of these samples.

Figure 2 shows the type 30 cement and bentonite grout samples after removal from the test vessels. These samples were in contact with brine under pressures varying from 0 to 6.9 MPa. for a period of approximately 8 months. From the photographs it is obvious to see that these samples performed poorly. The greatest deterioration occurred with the high pressure confined samples. However, none of the test samples remained fully intact. The cause of this poor performance was not readiliy apparent. Further testing is being considered for the 1990 program in an attempt to determine the mechanism or cause of this rather dramatic deterioration.

5.1.1 Compressive Strength

The strength of grout usually gives an overall picture of the quality of the grout as strength is directly related to the structure of the hardened cement paste. The compressive strengths, 40, 90, and 365 days of both grouts with and without fly ash are given in Table 4. It can be observed that the compressive strength is increasing with age for all mixes. No uniform pattern was observed when comparing individual mixes. Generally, under similar pressure, the compressive strength of grout specimens containing no fly ash have a similar strength to those with 40 percent fly ash.

5.1.2 Tensile Strength

Table 5 shows the average tensile strength at 40, 90 and 365 days. The tensile strength for both grouts with 0 and 40% were found to increase with age showing a similar pattern to that obtained from the compressive strength data. It is interesting to note that for a given age, tensile strengths decrease when confining pressures are increased.

5.1.3 Modulus of Elasticity

Table 6 gives the modulus of elasticity for specimens containing 0 and 40% fly ash. The modulus of elasticity was found to increase in value with time. The modulus of elasticity of grouts with 40% fly ash were higher, at 40 days, than those of similar grouts containing no fly ash.

5.1.4 Resonant Frequency Test

This test is used to determine indirectly any changes in density, porosity, and mixture composition in the grout specimens. Table 8 gives the resonant frequency readings obtained for grouts containing 0 and 40% fly ash at 20, 40, 90 and 365 days. For a given mix the resonant frequency was found to increase with time indicating a denser grout at later age. The resonant frequency at 365

days for grouts containing no fly ash were higher than those of similar grouts containing 40% fly ash. This may indicate that fly ash grouts are becoming more dense with less porosity at 365 days.

5.1.5 Micro-Structure Study

Grout specimens with 0 and 40 percent fly ash stored in brine solution for one year under confining pressures at 0, 3.4, and 6.90 MPa (0, 500, 1000 psi) were split and the mid-section was examined using a scanning electron microscope. The microscope was equipped with an electron probe x-ray micro-analyzer.

The dominant feature identified by the microscopic study on the samples, with and without fly ash, was the presence of long and short curly fibre crystals (Figure 3a - 3d). These were identified by the electron probe x-ray micro-analyzer to be sodium chloride salt. Similar observations were also found on samples cured for a shorter period of time (i.e., 40 days, 90 days). Figures 4a and 4b show that the gel structure in fly ash cement paste is relatively more dense than that with no fly ash. Apparently more gel substance filled the space available which is an indication for a reduced permeability of the paste.

A detailed study of the fibres on the fractured surface of the split specimens was performed to investigate their structural formation and characteristics. Figures 5a - 5d show the fracture process caused some of the matrix materials to stretch until they broke. The extruded material could not return to its original shape and fibres were formed. Figure 5b clearly shows massive material being stretched. Bundles of broken fibres were commonly found in porous areas where some spaces were left empty after the fibres had been stretched and broken (Figure 5c and 5d). These fibres can be described as visco-elastic to inelastic material.

Generally, fly ash cement paste was found to have less fibres than no fly ash paste. This may indicate that fly ash cement paste possesses a less permeable structure which inhibits the infiltrating of brine solution into the matrix system to form the fibres.

The present study reveals only a slight difference in paste microstructure of grout subjected to different confining pressures. More dense and compact microstructures were observed in cement and fly ash cement pastes subjected to a higher confining pressure (Figures 6a - 6d).

5.2 CHEMICAL GROUT PROPERTIES

All the chemical grout samples were prepared during December, 1988. These grout samples were then divided into three groups and submerged in brine under three different confining pressures of 0, 3.4, and 6.9 MPa. Visual inspection and weight loss measurement on each specimen was conducted at ages of 40 days, 90 days and 365 days. The changes in weight at different ages and pressures are given in Tables 8 to 13. The findings from visual inspection and weight measurements at different ages are summarized as follows:

5.2.1 AV-100 CHEMICAL GROUT

a) 40 day examination

No gaps were found between the grout specimens and the plastic containers for all three confining pressures. The weight of all specimens at 40 days increased slightly after submerging in brine regardless of the confining pressure (Table 8 to 10). This suggests that AV-100 chemical grouts did not have a significant shrinkage during the first forty days. The color of the AV-100 chemical grout sample under all pressures changed from green to blue. The color of the top 0.75

inch of the samples that were subjected to 1,000 psi confining pressure were changed to clear color. However, the samples that were subjected to lower confining pressures did not have this change in color.

b) 90 days examination

All AV-100 chemical grout samples under different pressures were still in contact with the plastic containers. No evidence of shrinkage was observed. No weight loss of any samples was detected (Table 8 to 10). The thickness of the top clear layer of the specimens that were subjected to 6.9 MPa (1000 psi) confining pressure, was increased to about 3 cm (1.2 inches). The top 1.3 cm (0.5 inch) of AV-100 grout samples was subjected to 3.4 MPa (500 psi) confining pressure also had a color change from blue to clear. The samples that were subjected to 0 psi confining pressure were blue in color. No clear layer was found in this group. The thickness of the clear layer seemed to be a function of the submerged pressure.

c) 365 day examination

No visual gaps were observed between grout specimens and plastic containers contained the grouts. A small increase in weight of all specimens were measured. No visual evidence of shrinkage were observed on any specimens. Some specimens under 6.9 MPa (1000 psi) confining pressure were found to be loose in their containers. It seems that a slight shrinkage have occurred on these specimens. The specimens under 0 Mpa (0 psi) and 3.4 MPa (500 psi) remained in contact with the plastic container as was previously observed. The color of the specimens subjected to 3.4 MPa (500 psi) and 6.9 MPa (1000 psi) pressure was changed to a clear color (Figure 7). The color of the top 1.3 cm (0.5 inch) of the specimens that were under 0 MPa changed from blue to clear. The color change from blue to clear, seems to be a function of time.

5.2.2 GEOCHEM AC-400

a) 40 day examination

The weight of all specimens of this group under different pressures were found to decrease slightly (Table 11 to 13). Gaps of approximately 0.25 cm (0.1 inch) were found between the samples and the plastic containers for specimens under the three different pressures. The color of all specimens remained white under different pressures.

b) 90 day examination

The weight of all specimens at 90 days continued to decrease (Table 11 to 13). The gaps between the samples and the plastic containers increased to approximately 5 mm (0.2 inch) for all samples. This may suggest that shrinkage is increasing with time for these chemical grouts when submerged in brine. The color of all specimens remained unchanged.

c) 365 day examination

The weight of specimens under 3.4 MPa (500 psi) and 6.9 MPa (1000 psi) continued to decrease, and the gaps between the sample and the containers continue to increase at this stage (Figure 8 and 9). The weight of the specimens under 0 MPa (0 psi) at 365 days increased slightly compared to the weight measured at 40 days. This is because some brine in the 0 MPa (0 psi) container evaporated and leaving salt crystal on the top of the specimen (Figure 10). The gaps between the samples and the plastic containers increased to about 0.7 cm (0.3 inch) for all specimens. The color of all specimens remained the same.

6.0 SUMMARY

The research into the long-term (up to 5 years) performance of grouts in brine environments is proceeding favourably. Selected chemical and cement based grouts have been evaluated after 40, 90 and 365 days of exposure to brine under fluid pressures of 0, 3.4 and 6.9 MPa. The results of tests conducted on these samples has shown some significant differences in performance of grouts.

The original proposal for this research envisaged the testing of only four different grouts. These grouts would be evaluated (including destructive testing) at various time intervals during a five year test program. At the end of the test program the data was to be analysed and a final report prepared. This proposal has evolved somewhat since the start of the program to accommodate other potential grout materials. In addition, some analysis of the data is being conducted during the test program to help focus the research on the most promising grouts.

In 1990 additional test samples will be prepared to replace some of the samples used during the first three sets of tests. Some additional samples of other grouts may also be tested. An analysis of the test results of the 40, 90 and 365 day exposure brine exposed samples will also be conducted during 1990.

Table 1 Chemical composition and physical properties of portland cement Type III

Chemical Component	% by weight	ASTM C 150 Specifications
Silicon dioxide (SiO_2)	20.70	-
Aluminum oxide (Al_2O_3)	4.49	-
Iron oxide (Fe_2O_3)	3.13	-
Calcium oxide (CaO), Total	61.54	-
Calcium oxide (CaO), Free	1.70	-
Magnesium oxide (MgO)	3.90	6.0 max.
Sulfur trioxide (SO_3)	3.34	3.5 max.
Loss of ignition	1.70	3.0 max.
Insoluble residue	0.20	0.75 max.
Alkalies (Na_2 + 0.658 K_2O)	0.60	0.60
Physical tests		
Time of setting in minutes (vicat test)	80.0	45 min., 375 max.
Autoclave expansion, percent	0.12	0.80
Compressive strength at		
1 day	25.9 MPa (3760 psi)	12.4 MPa (1800 psi) min.
3 days	31.2 MPa (4525 psi)	24.1 MPa (3500 psi) min.
7 days	47.8 MPa (6930 psi)	-

Percent passing No. 325 (45-mm) sieve = 96.3

Blaine fineness = 537 m^2/kg

Table 2 Chemical composition and physical properties of Saskatchewan lignite fly ash

Chemical Component	% by weight	ASTM C 618 Specifications Class C
Silicon Dioxide (SiO_2)	46.80	-
Aluminum oxide (Al_2O_3)	21.90	-
Iron oxide (Fe_2O_3)	3.90	-
Total ($SiO_2 + Al_2O_3 + Fe_2O_3$)	72.60	50.0 min.
Sulphur trioxide (SO_3)	0.80	5.0 max.
Calcium oxide (CaO)	12.40	-
Available alkalies as Na_2O	3.64	1.5 max.
Moisture content	0.09	3.0 max.
Loss of ignition	0.61	6.0 max.
Physical tests		
Fineness retained on 45-μm (No. 325) sieve, Percent	19.83	34.0 max.
Pozzolanic activity index		
With portland cement, percent ratio to control at 28 days	75.00	75.0 min.
with lime at 7 days, psi	6.36 MPa (925.0 psi)	5.51 MPa (800.0 psi) min.
Water requirement, percent of control	91.0	105.0 max.
Autoclave expansion, percent	0.07	0.8 max.
Specific gravity	2.36	--

Table 3 Chemical composition of brine water

Constituents	mg/liter
Cations	
Total hardness*	39,600
Calcium Hardness*	32,500
Magnesium Hardness*	7,100
Sodium as Na	95,600
Potassium as K	4,500
Iron as Fe	less than 0.05
Manganese as Mn	less than 0.03
Anions	
P. alkalinity*	0.00
Carbonate as CO_3	0.00
Total Alkalinity*	18
Bicarbonate as HCO_3	22
Chloride as Cl	178,700
Nitrate as NO_3	less than 0.2
Fluoride as F	0.0
Sulfate as SO_4	486
Total dissolved solids	
By evaporation at 103 C	333,600
By conductivity at 25 C	426,160
Appearance:	Clear, colorless
Odor	H_2S
pH	6.3

* expressed as $CaCO_3$

Table 4 Compressive strength (MPa) of cement grout at different ages and pressures

Pressure(MPa)	% Fly ash	40 days	90 days	365 days
0	0	1.90	1.70	--
		1.68	2.04	--
		--	2.60	--
Average		**1.79**	**2.11**	**-**
3.4	0	1.81	2.01	4.19, 4.77
		2.47	2.17	4.68, 4.68
		1.70	--	4.77, 3.88
Average		**1.99**	**2.09**	**4.50**
6.9	0	2.26	2.35	4.29, 4.19
		2.38	2.60	4.28, 3.21
		--	2.72	4.38, 3.80
Average		**2.32**	**2.56**	**4.03**
0	40	2.72	4.66	5.26
		2.11	4.07	5.85
		1.45	4.21	7.8, 6.24
Average		**2.09**	**4.31**	**6.29**
3.4	40	1.92	2.72	4.38
		2.42	3.76	4.38
		1.77	2.26	4.09
Average		**2.04**	**2.91**	**4.28**
6.9	40	1.47	2.85	3.12
		2.13	3.40	4.58
		2.13	3.83	3.41
Average		**1.91**	**3.36**	**3.90**

Table 5 Tensile strength (MPa) of cement grout at different ages and pressures

Pressure(MPa)	% Fly ash	40 days	90 days	365 days
0	0	0.30	0.45	--
		0.54	0.63	--
Average		**0.42**	**0.54**	**--**
3.4	0	0.39	0.63	0.77, 0.88
		0.40	0.49	0.77, 1.02
				1.02, 1.33
Average		**0.40**	**0.56**	**0.97**
6.9	0	0.37	0.49	0.49, 0.33
		0.37	---	1.21, 0.37, 0.70
Average		**0.37**	**0.49**	**0.62**
0	40	0.30	0.87	1.29, 1.58
		0.27	1.01	1.68, 1.49
Average		**0.29**	**0.94**	**1.51**
3.4	40	0.29	0.77	0.77, 0.70
		0.23	0.66	0.85
Average		**0.26**	**0.72**	**0.77**
6.9	40	0.33	0.54	0.73, 0.55
		0.30	0.73	0.60, 0.59
Average		**0.32**	**0.64**	**0.62**

Table 6 Modulus of Elasticity (MPa) for cement grout at different ages and pressures

Pressure(MPa)	% Fly ash	40 days	90 days	365 days
0	0	2189	2390	--
		1871	3420	--
Average		**2030**	**2905**	--
3.4	0	3068	1750	1904, 1536
		2631	3380	2463, 1871
		--	3250	2272, 2257
Average		**2850**	**2793**	**2051**
6.9	0	2510	3040	1571, 2239
		2950	2630	2366, 1854
		1946	--	1680, 2223
Average		**2469**	**2835**	**1989**
0	40	1407	3210	2159
		1174	2320	2668
		891	1900	--
Average		**1157**	**2477**	**2414**
3.4	40	1073	2320	2572
		1473	2500	2182
		1335	--	2889
Average		**1294**	**2410**	**2548**
6.9	40	1168	1390	2159
		1687	2200	2668
		938	2210	--
Average		**1264**	**1933**	**2414**

Table 7 Resonant frequency for cement grout at different ages and pressures

Pressure (MPa)	% Fly ash	20 days	40 days	90 days	365 days
0	0	2310	2320	2437	4049
		2860	2085	2370	4056
		2210	–	–	4044
Average		**2460**	**2203**	**2404**	**4050**
3.4	0	2001	2922	2450	4175
		2080	2090	3380	2537
		2280	2245	2235	–
		2270	2235	2430	–
Average		**2184**	**2373**	**2624**	**3356**
6.9	0	2225	2323	2440	4044
		2265	2150	2400	4190
		2385	2325	2300	4078
		2350	2190	2530	3949
		2310	–	2397	4125
		2160	2010	2180	4105
Average		**2283**	**2200**	**2375**	**4082**
0	40	2160	2260	2670	4057
		2060	2310	2840	2761
		1980	2270	2860	2518
		1994	2320	3082	2933
Average		**2049**	**2290**	**2863**	**3067**
3.4	40	2065	2364	2280	2406
		2100	2320	2234	2183
		2110	2410	2383	2404
		2040	2300	3982	3253
		2150	2378	2268	3252
		1860	2270	2446	2455
Average		**2054**	**2340**	**2599**	**2659**
6.9	40	1930	2290	2218	2431
		2320	2356	2316	2741
		1920	2236	2228	2420
		1935	–	–	2590
		2170	2380	2297	2554
		1980	2380	2111	2729
Average		**2043**	**2328**	**2234**	**2578**

TABLE 8

ADVANTI AV 100
CHEMICAL GROUT (GREEN)
STORAGE PRESSURE : 0 kPa (0 PSI)

	0 DAY	40 DAYS	90 DAYS	365 DAYS
SAMPLE NUMBER	WEIGHT (g)	WEIGHT (g)	WEIGHT (g)	WEIGHT (g)
43			330	334.7
44			328.6	334.64
45			337	348.84
46			327	333.5
47			342.9	365.92
48			31.75	323.24
49			328.3	337.75
50			334.9	343.79
51	321.50	325.33	327.8	334.78
52	325.68	329.54	332	339.4
53	319.32	328.21	330.7	335.72
54	309.64	315.85	318	324.8
55	323.01	326.83	329.5	341.15
56	326.19	332.99	335.1	348.29
57	315.98	319.92	322.7	340.09
58	325.47	332.54	334.3	340.92
59	316.36	325.70	327.1	331.7
60	325.63	329.40	331.5	338.72
61	328.42	332.93	335.1	342.16
62	338.90	343.29	345.9	352.8
63	324.42	328.50	331.3	337.74
64	313.52	317.61	320.1	325.62

TABLE 9

ADVANTI AV-100 (GREEN)
CHEMICAL GROUT
STORAGE PRESSURE : 3448 kPa (500 PSI)

	0 DAYS	30 DAYS	90 DAYS	365 DAYS
SAMPLE NO.	WEIGHT (g)	WEIGHT (g)	WEIGHT (g)	WEIGHT (g)
22			334.7	333.84
23			332.8	331.55
24			315	315.69
25			332.5	333.11
26	315.09	320.38	324.6	305.94
27	322.43	336.44	337.4	336.86
28	323	329.21	335.6	323.81
29	317.94	323.44	324.5	326.72
30	317.97	326.02	327.3	328.79
31	319.09	322.67	326.6	328.48
32	332.06	336.14	340.2	341.65
33	332.9	337.94	340.7	341.97
34	320.47	331.75	333.8	330.6
35	327.57	331.82	334.8	336.93
36	310.16	316.27	317.4	320.01
37	336.05	341.4	344.1	346.07
38	325.75	331.3	332.3	335.36
39	318.81	323.65	327.3	327.91
40	313.19	319.26	321.7	322.46
41	326.58	331.03	344	335.56
42	319.99	325.58	328.9	329.68
43	320.61	328.04		
44	319.33	326.7		
45	330.36	334.26		
46	319.99	324.42		
47	336.02	340.31		
48	310.44	314.67		
49	321.75	325.47		
50	328.23	331.87		

TABLE 10

ADVANTI AV-100 (GREEN)
CHEMICAL GROUT
STORAGE PRESSURE : 6895 kPa (1000 PSI)

	0 DAYS	40 DAYS	90 DAYS	365 DAYS
SAMPLE NUMBER	WEIGHT (g)	WEIGHT (g)	WEIGHT (g)	WEIGHT (g)
1	331.57	339.43	341.0	350.8
2	320.91	329.98	330.4	331.61
3	309.80	321.18	321.4	323.32
4	327.53	338.45	338.5	340.05
5	324.76	336.06	335.5	337.99
6	300.60	312.28	310.0	312.52
7	327.99	335.23	336.1	341.91
8	325.33	335.10	335.8	339.32
9	330.71	335.53	338.0	348.33
10	319.56	330.11	330.5	331.34
11	307.71	318.17	319.7	324.48
12	340.42	348.31	349.9	352.09
13	294.60	308.76	309.8	309.39
14	312.08	319.54	321.3	323.41
15	324.98	331.81	334.4	336.75
16	333.25	344.82	347.0	352.94
17	318.53	325.44	329.8	330.3
18	331.36	335.91	339.5	342.99
19	319.98	328.10	330.4	334.4
20	333.29	338.24	341.0	346.92
21	320.21	326.84	329.3	331.97
22	324.37	332.11		
23	319.87	329.32		
24	301.60	312.18		
25	321.64	329.46		

TABLE 11

GEOCHEM AC-400
CHEMICAL GROUT (WHITE)
STORAGE PRESSURE: 0 kPa (0 PSI)

SAMPLE NUMBER	0 DAYS WEIGHT (g)	40 DAYS WEIGHT (g)	90 DAYS WEIGHT (g)	365 DAYS WEIGHT (g)
33	225.14	178.51	175.7	188.38
34	229.23	185.63	181.3	191.66
35	228.62	181.5	178.8	193.3
36	244.43	193.5	189.7	200.86
37	220.41	181.81	195.7	185.16
38	245.09	194.53	189.6	200.55
39	249.82	195.94	193.2	205.23
40	214.85	176.82	170.3	182.87
41	236.9	187.89	183.6	195.84
42	239.62	187.59	183.6	194.41
43	219.8	180.76	174	184.67
44	249.61	197.17	192.8	204.15
45	243.95	192.52	188.1	200.9
46	228.02	183.85	177.5	189.51
47	242.52	195.29	189	201.8

TABLE 12

GEOCHEM AC-400 (WHITE)
CHEMICAL GROUT
STORAGE PRESSURE : 3448 kPa (500 PSI)

SAMPLE NUMBER	0 DAY WEIGHT (g)	40 DAYS WEIGHT (g)	90 DAYS WEIGHT (g)	365 DAYS WEIGHT (g)
17	237.07	198.35	196.5	190.67
18	229.2	189	200.7	180.96
19	224.91	192.8	182.3	178.03
20	235.99	210.45	186.3	198.68
21	280.26	235.17	228.4	222.64
22	225.82	186.4	185.2	179.17
23	246.02	201.85	208.4	193.31
24	222.85	194	181.9*	182.39
25	230.08	197.46	192.8	182.68
26	220	188.7	182.4	174.65
27	236.65	196	195.6	186.51
28	241.03	198.15	191.8	190.47
29	228.23	196.6	182.4	181.361
30	229.02	204.9	192	184.28
31	222.32	183.39	179.2	175.76
32	234.27	194.56	193.5	188.55

* sample was upside down when removed.
Some material may been lost.

TABLE 13

GEOCHEM AC-400
CHEMICAL GROUT (WHITE)
STORAGE PRESSURE : 6895 kPa (1000 PSI)

SAMPLE NUMBER	0 DAYS WEIGHT (g)	40 DAYS WEIGHT (g)	90 DAYS WEIGHT (g)	365 DAYS WEIGHT (g)
1	239.66	194.83	196.3	188.6
2	246.52	203.19	196.9	190.12
3	242.23	199.36	192.1	162.94
4	225.93	181.53	184.9	178.78
5	238.07	196.17	187.8	186
6	240.43	200.51	192.5	189.23
7	245.91	500.78	188.1	187.56
8	224.77	184.89	181.8	177.32
9	204.79	167.63	168.9	187.97
10	243.39	202.09	196.1	194.87
11	211.41	182.74	168.2	167.54
12	241.97	196.55	198.3	192.73
13	238.18	197.51	189.4	189.27
14	239.94	198.75	199.3	190.72
15	248.9	204.77	201.8	195.08
16	231.15	189.59	192.2	184.5

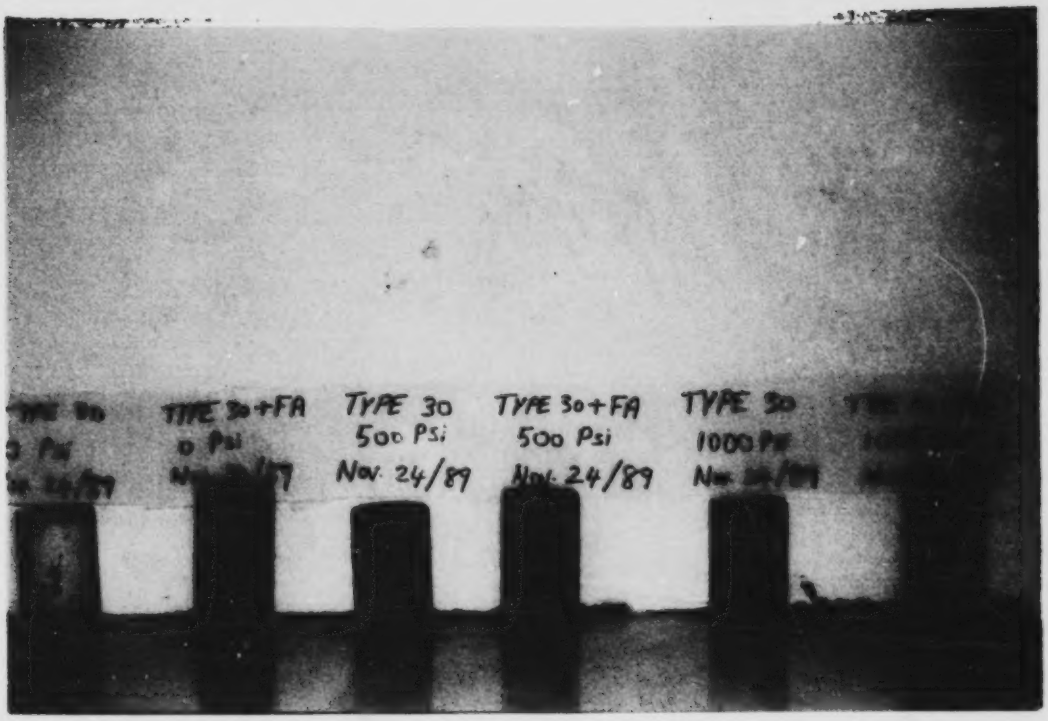


Figure 1: Photograph showing the cement grout specimens after being stored under different confining pressures.

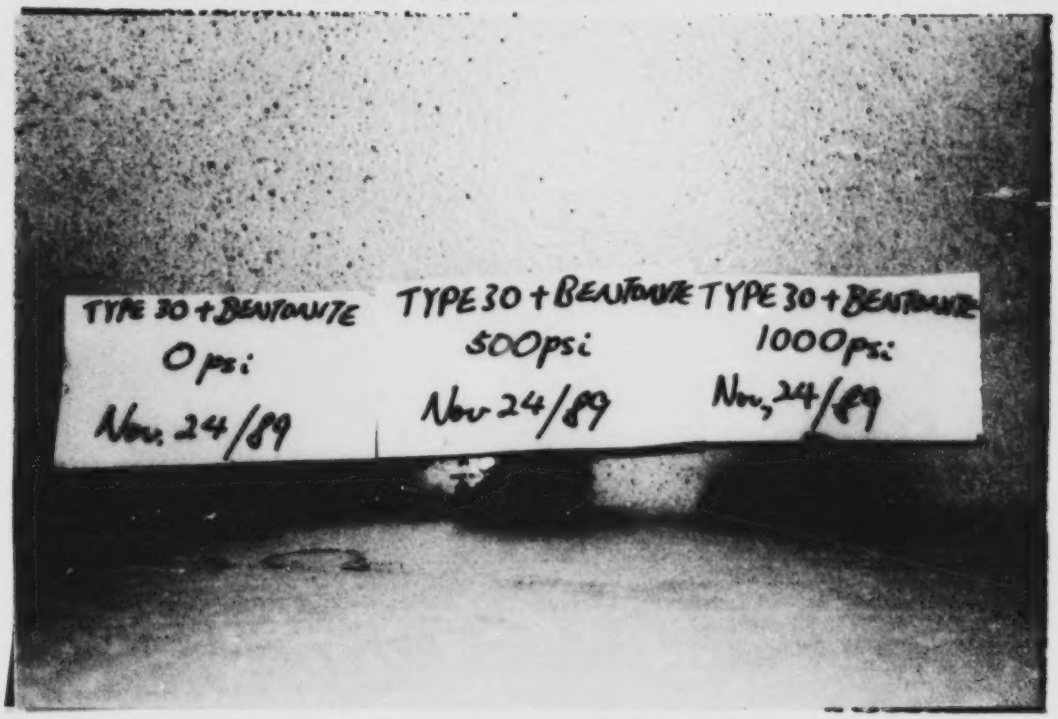
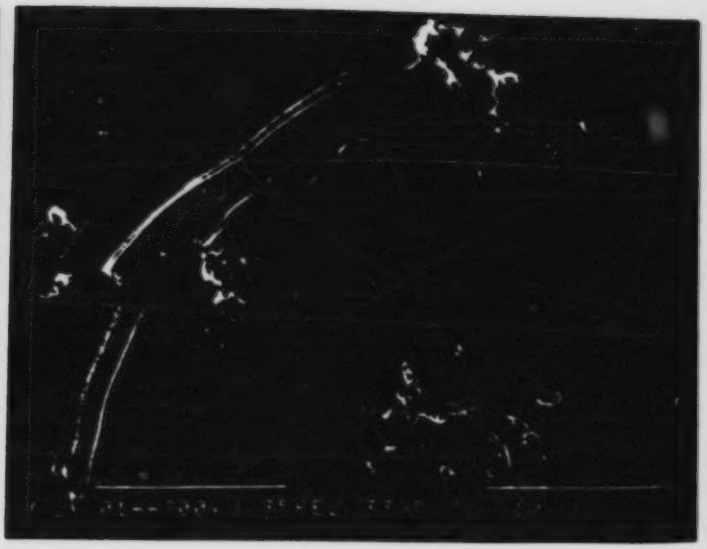


Figure 2: Photograph showing cement grout with bentonite specimens after being stored under different confining pressures.

(a)
Fly ash-cement paste
Confining pressure: 3.4 MPa (500 psi)
Magnification: x1420

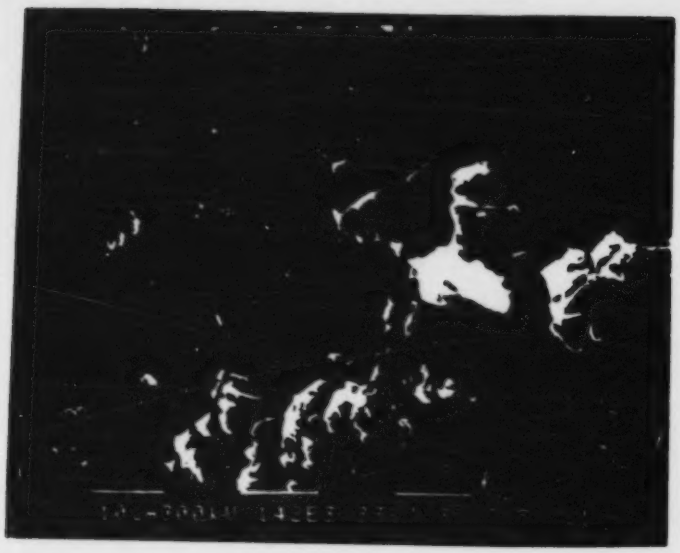


(b)
Cement paste
Confining pressure: 6.9 MPa (1000 psi)
Magnification: x356

(c)
Cement paste
Confining pressure: 3.4 MPa (500 psi)
Magnification: x356

(d)
Cement paste
Confining pressure: 3.4 MPa (500 psi)
Magnification: x356

Figure 3: SEM photos showing the long and short curly fibers in the pastes



(a)

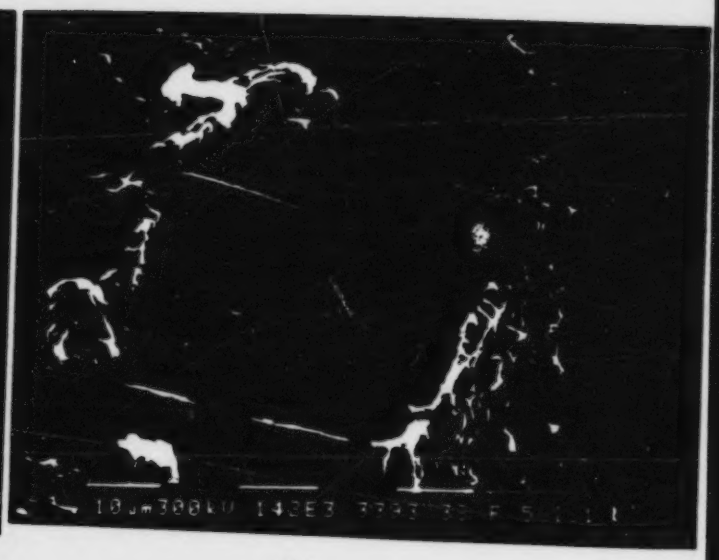
Cement paste-less dense structure
Magnification: x1420

(c)

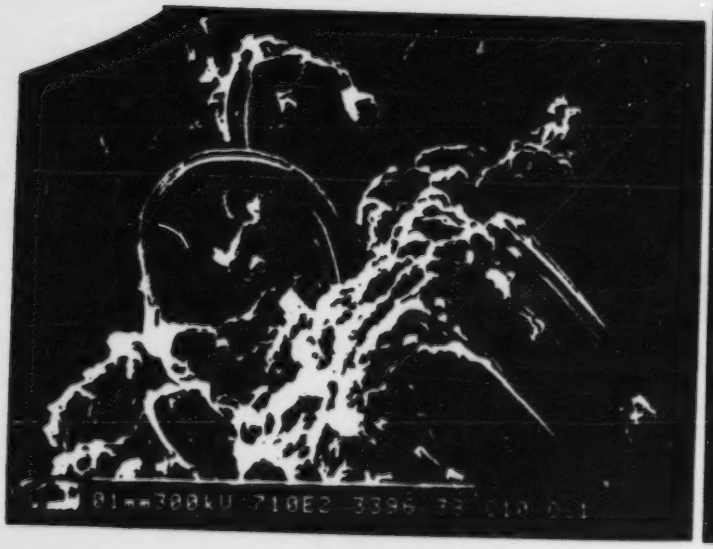
Fly ash-cement paste-dense structure
Magnification: x1420

Figure 4: SEM photos showing the structures of pastes subjected to a confining pressure of 3.4 MPa (500 psi)

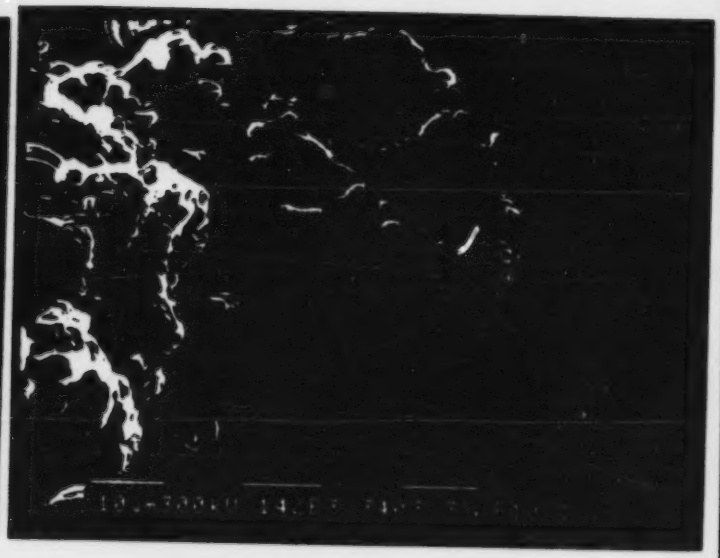
(a)
Cement paste
Confining pressure: 3.4 MPa (500 psi)
Magnification: x1420



(b)
Fly ash-cement paste
Confining pressure: 3.4 MPa (500 psi)
Magnification: x1420

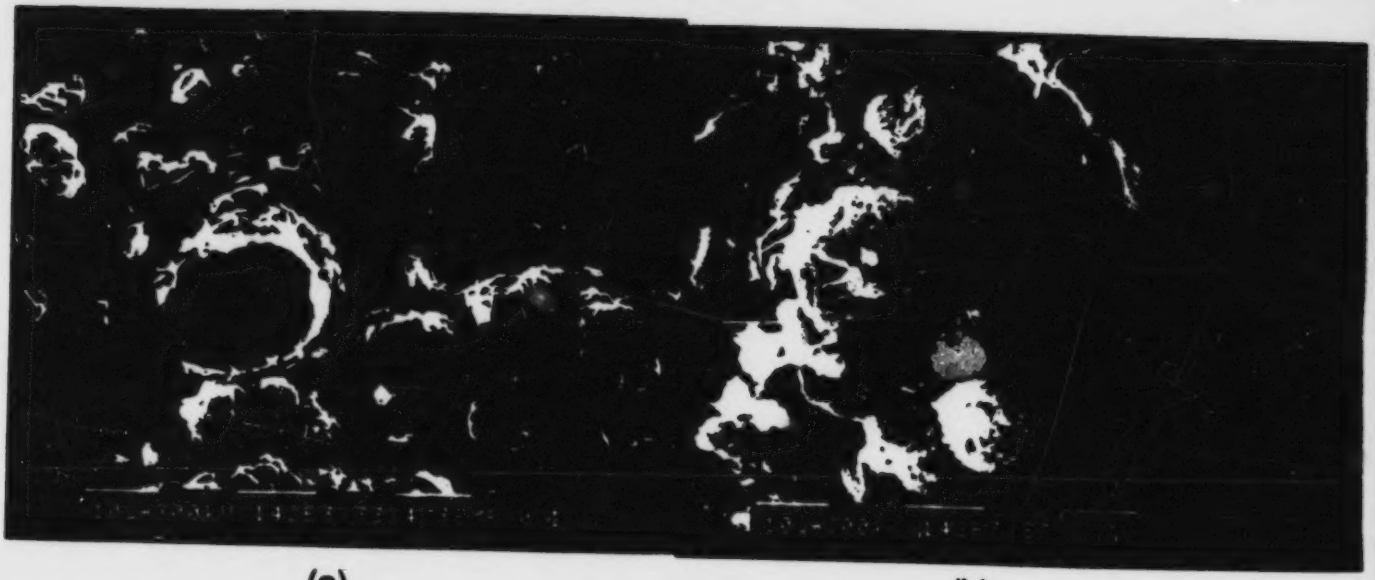


(c)
Cement paste
Confining pressure: 6.9 MPa (1000 psi)
Magnification: x710



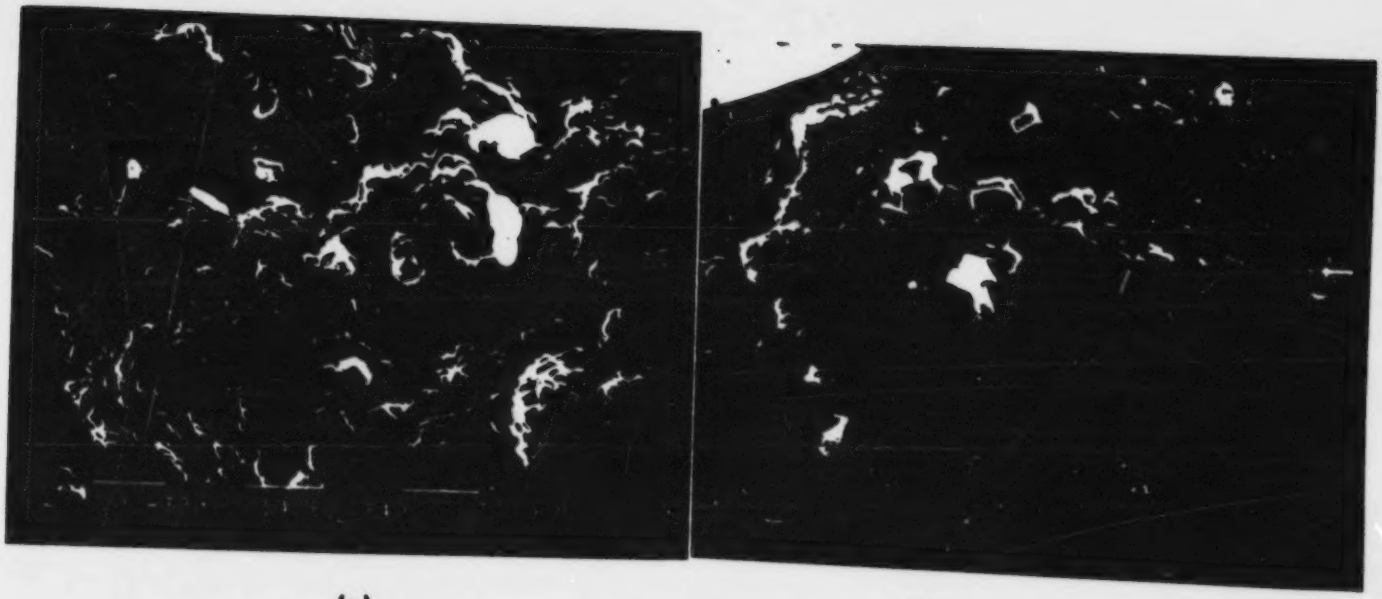
(d)
Fly ash-cement paste
Confining pressure: 6.9 MPa (1000 psi)
Magnification: x1420

Figure 5: SEM photos showing the extruded materials on the fracture surface of the pastes



(a)
Fly ash-cement paste
Confining pressure: 0 MPa (0 psi)
Magnification: x1420

(b)
Fly ash-cement paste
Confining pressure: 0 MPa (0 psi)
Magnification: x1420



(c)
Fly ash-cement paste
Confining pressure: 6.9 MPa (1000 psi)
Magnification: x1420

(d)
Cement paste
Confining pressure: 6.9 MPa (1000 psi)
Magnification: x1420

Figure 6: SEM photos showing the structure of pastes subjected to different confining pressures

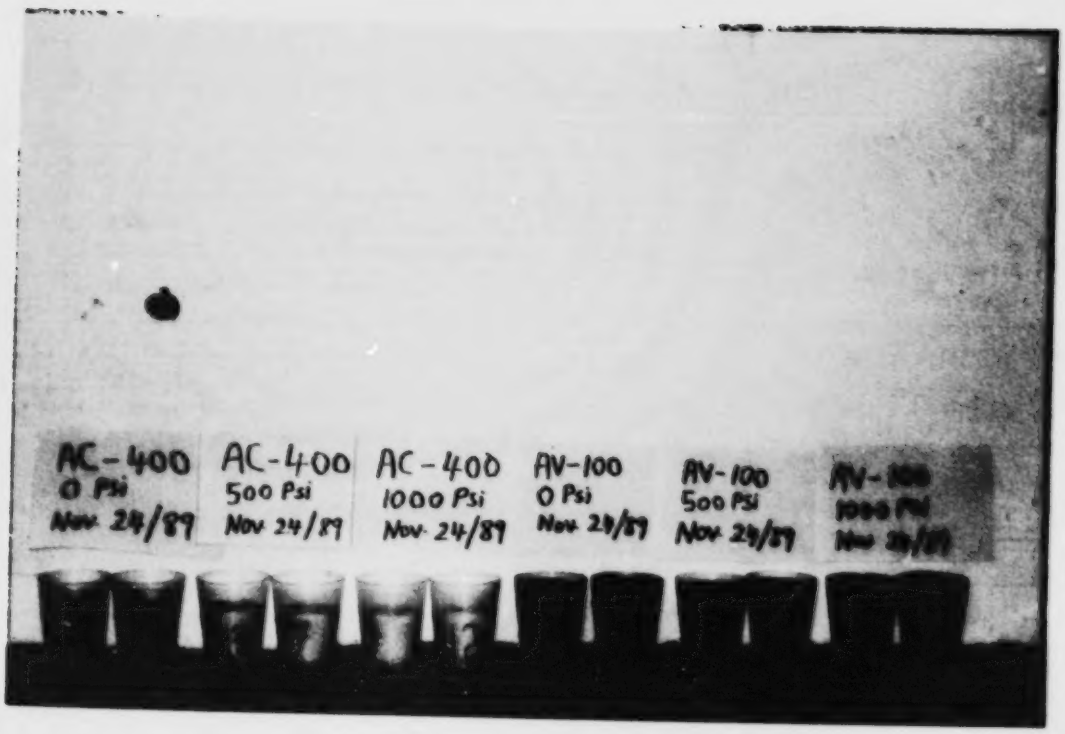


Figure 7: Photograph showing the chemical grout specimens after being stored under different confining pressures for one year.

Figure 8: Photograph showing the AC-400 specimens after being stored under a confining pressure of 6.9 MPa (1000 psi) for one year. This Photograph shows the gap between the sample and the container.

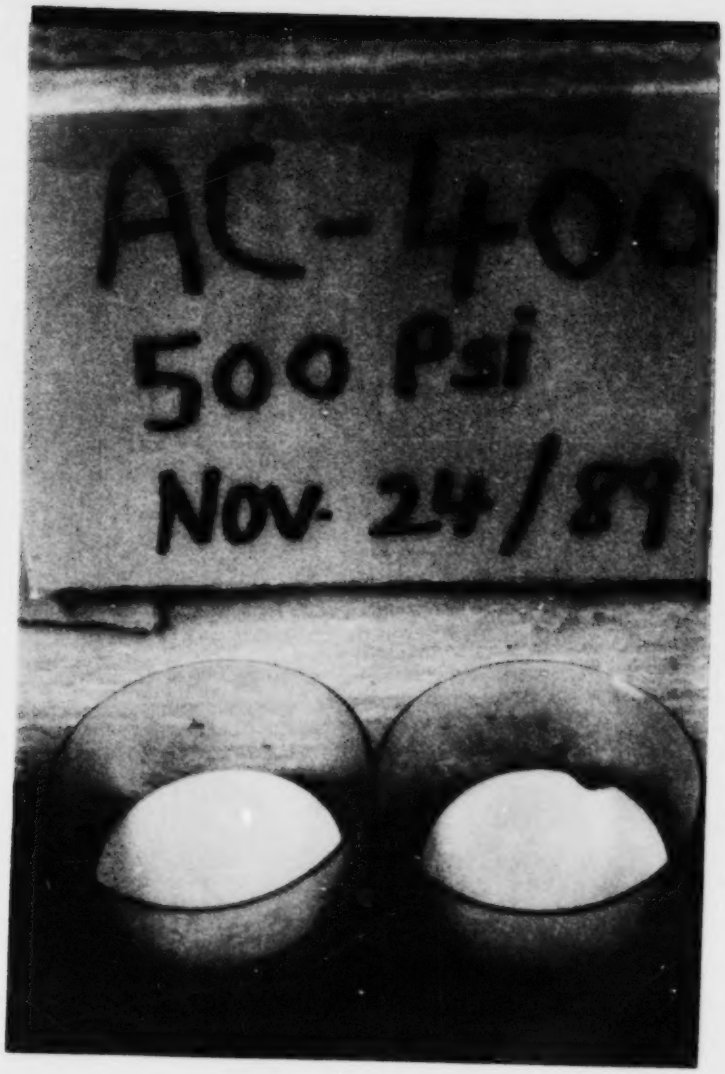


Figure 9: Photograph showing the AC-400 specimens after being stored under a confining pressure of 3.4 MPa (500 psi) for one year. This Photograph shows the gap between the sample and the container.

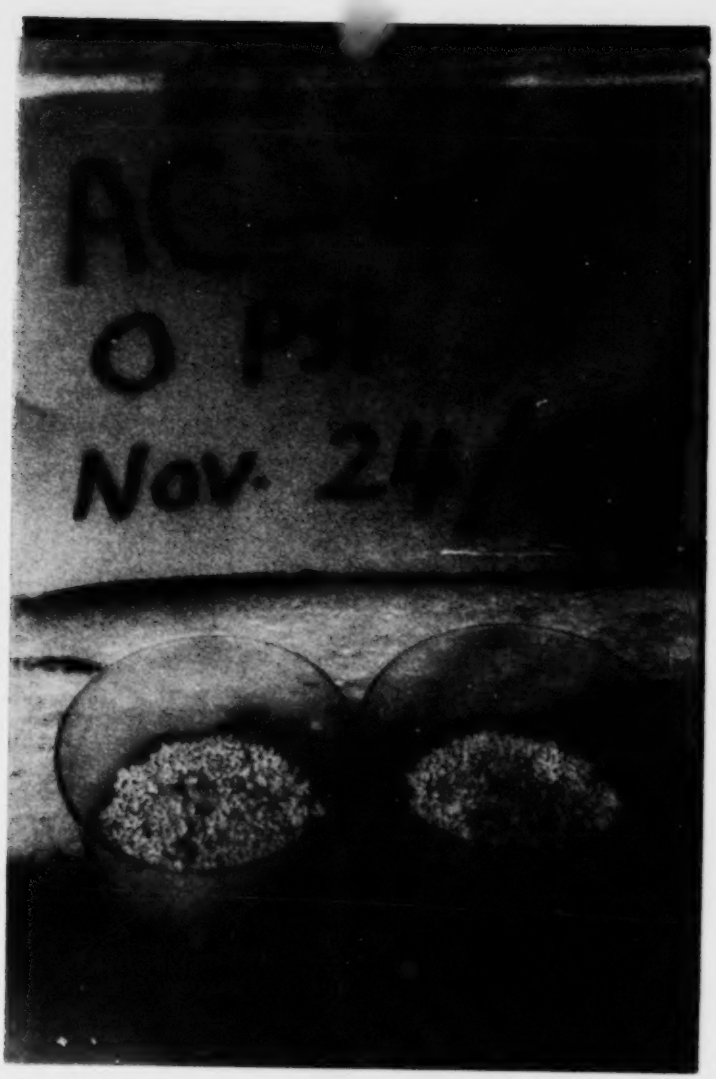


Figure 10: Photograph showing the AC-400 specimens after being stored under a confining pressure of 0 MPa (0 psi) for one year. This Photograph shows the salt crystals on top of the sample.

APPENDIX

GROUT TEST DATA

Sample Number FLYASH	Date	Sonic Reading	Comments	Storage Pressure (psi)	Dia.1 (mm)	Dia.2 (mm)	Dia.3 (mm)	Avg. Dia. (mm)	Length (mm)	Weight (g)
45	5/1/89			0	75.90	76.25	75.90	76.02	137.17	936.17
51	5/1/89			0	75.80	75.81	75.84	75.82	152.53	975.99
52	5/1/89			0	75.84	75.76	75.90	75.83	134.43	926.26
53	5/1/89			0	75.92	75.82	75.74	75.83	145.48	978.22
54	5/1/89			0	76.11	75.85	75.94	75.97	134.03	924.32
55	5/1/89			0	75.81	75.80	75.90	75.84	134.41	935.41
56	5/1/89			0	76.11	75.31	75.97	75.80	135.17	933.03
57	5/1/89			0	76.07	75.71	76.08	75.95	137.62	949.41
58	5/1/89			0	74.76	75.54	75.54	75.28	133.54	1201.82
59	5/1/89			0	75.91	75.62	75.81	75.78	153.15	1016.13
60	5/1/89			0	76.18	75.90	76.00	76.03	143.92	975.44
61	5/1/89			0	75.98	75.97	75.89	75.95	147.48	988.41
62	5/1/89			0	75.90	75.90	75.75	75.85	140.70	945.26
63	5/1/89			0	75.66	75.30	75.84	75.60	130.48	919.29
64	5/1/89			0	75.93	75.80	75.73	75.82	153.11	1036.67
65	5/1/89			0	75.63	75.56	75.93	75.71	152.53	985.54
66	5/1/89			0	75.78	75.47	75.74	75.66	153.06	991.94
67	5/1/89			0	75.05	75.22	75.90	75.39	131.59	1212.47
68	5/1/89			0	75.68	75.75	75.60	75.68	153.10	1020.72
69	5/1/89			0	75.50	75.90	75.88	75.76	133.54	931.02
70	5/1/89			0	75.84	75.38	75.61	75.61	135.60	935.37
71	5/1/89			0	75.00	75.74	75.82	75.52	152.90	1007.16
72	5/1/89			0	75.93	75.75	75.88	75.85	153.12	1007.33
73	5/1/89			0	75.75	75.63	75.87	75.75	135.94	938.03
74	5/1/89			0	75.77	75.99	75.69	75.82	151.53	1008.10
75	5/1/89			0	75.70	75.43	75.91	75.68	134.76	932.51
76	5/1/89			0	75.56	75.56	75.32	75.48	152.69	1011.86
77	5/1/89			0	75.66	73.09	75.48	74.74	152.15	994.22
78	5/1/89			0	75.75	75.93	75.88	75.85	153.12	1037.32
79	5/1/89			0	75.86	75.26	75.64	75.59	152.07	1001.55
80	5/1/89			0	75.87	75.16	75.76	75.60	144.87	973.45
81	5/1/89			0	75.70	75.64	75.87	75.74	151.46	1009.80

Sample Number FLYASH	Date	Sonic Reading	Comments	Storage Pressure (psi)	Dia.1 (mm)	Dia.2 (mm)	Dia.3 (mm)	Avg. Dia. (mm)	Length (mm)	Weight (g)
45	5/1/89			0	75.90	76.25	75.90	76.02	137.17	936.17
51	5/1/89			0	75.80	75.81	75.84	75.82	152.53	975.99
52	5/1/89			0	75.84	75.76	75.90	75.83	134.43	926.26
53	5/1/89			0	75.92	75.82	75.74	75.83	145.48	978.22
54	5/1/89			0	76.11	75.85	75.94	75.97	134.03	924.32
55	5/1/89			0	75.81	75.80	75.90	75.84	134.41	935.41
56	5/1/89			0	76.11	75.31	75.97	75.80	135.17	933.03
57	5/1/89			0	76.07	75.71	76.08	75.95	137.62	949.41
58	5/1/89			0	74.76	75.54	75.54	75.28	133.54	1201.82
59	5/1/89			0	75.91	75.62	75.81	75.78	153.15	1016.13
60	5/1/89			0	76.18	75.90	76.00	76.03	143.92	975.44
61	5/1/89			0	75.98	75.97	75.89	75.95	147.48	988.41
62	5/1/89			0	75.90	75.90	75.75	75.85	140.70	945.26
63	5/1/89			0	75.66	75.30	75.84	75.60	130.48	919.29
64	5/1/89			0	75.93	75.80	75.73	75.82	153.11	1036.67
65	5/1/89			0	75.63	75.56	75.93	75.71	152.53	985.54
66	5/1/89			0	75.78	75.47	75.74	75.66	153.06	991.94
67	5/1/89			0	75.05	75.22	75.90	75.39	131.59	1212.47
68	5/1/89			0	75.68	75.75	75.60	75.68	153.10	1020.72
69	5/1/89			0	75.50	75.90	75.88	75.76	133.54	931.02
70	5/1/89			0	75.84	75.38	75.61	75.61	135.60	935.37
71	5/1/89			0	75.00	75.74	75.82	75.52	152.90	1007.16
72	5/1/89			0	75.93	75.75	75.88	75.85	153.12	1007.33
73	5/1/89			0	75.75	75.63	75.87	75.75	135.94	938.03
74	5/1/89			0	75.77	75.99	75.69	75.82	151.53	1008.10
75	5/1/89			0	75.70	75.43	75.91	75.68	134.76	932.51
76	5/1/89			0	75.56	75.56	75.32	75.48	152.69	1011.86
77	5/1/89			0	75.66	73.09	75.48	74.74	152.15	994.22
78	5/1/89			0	75.75	75.93	75.88	75.85	153.12	1037.32
79	5/1/89			0	75.86	75.26	75.64	75.59	152.07	1001.55
80	5/1/89			0	75.87	75.16	75.76	75.60	144.87	973.45
81	5/1/89			0	75.70	75.64	75.87	75.74	151.46	1009.80

Sample Number FLYASH	Date	Sonic Reading	Comments	Storage Pressure (psi)	Dia.1 (mm)	Dia.2 (mm)	Dia.3 (mm)	Avg. Dia. (mm)	Length (mm)	Weight (g)
26	5/1/89			500	75.69	76.05	76.07	75.94	139.21	938.34
27	5/1/89			500	75.75	76.15	75.83	75.91	142.30	959.03
28	5/1/89			500	75.88	75.83	75.91	75.87	142.31	963.31
29	5/1/89			500	76.09	75.59	75.83	75.84	136.88	928.35
30	5/1/89			500	76.17	75.48	75.75	75.80	137.89	943.32
31	5/1/89			500	75.69	75.89	76.00	75.86	137.11	928.56
32	5/1/89			500	76.02	75.74	75.74	75.83	142.57	970.36
33	5/1/89			500	76.82	75.68	75.82	76.11	139.74	947.83
34	5/1/89			500	75.67	76.13	75.84	75.88	141.68	958.45
35	5/1/89			500	75.68	75.89	75.83	75.80	153.15	1017.03
36	5/1/89			500	75.81	75.94	75.85	75.87	142.37	967.37
37	5/1/89			500	75.84	75.92	75.79	75.85	144.81	937.99
38	5/1/89			500	76.06	75.94	76.26	76.09	143.33	934.51
39	5/1/89			500	75.64	76.12	75.81	75.86	135.56	917.58
40	5/1/89			500	75.96	75.94	75.84	75.91	147.58	985.25
41	5/1/89			500	76.08	75.76	75.82	75.89	141.45	955.45
42	5/1/89			500	75.68	76.08	75.95	75.90	130.34	907.12
43	5/1/89			500	76.03	75.86	76.05	75.98	136.29	943.29
44	5/1/89			500	75.92	75.23	75.70	75.62	144.57	979.24
46	5/1/89			500	75.80	75.35	75.90	75.68	133.26	922.18
47	5/1/89			500	75.58	76.04	76.01	75.88	134.85	939.36
48	5/1/89			500	76.33	75.24	75.75	75.77	153.02	1008.72
49	5/1/89			500	75.80	75.86	75.90	75.85	132.54	1177.31
50	5/1/89			500	75.63	75.50	75.96	75.70	130.30	1192.54

Sample Number FLYASH	Date	Sonic Reading	Comments	Storage Pressure (psi)	Dia.1 (mm)	Dia.2 (mm)	Dia.3	Avg. Dia. (mm)	Length (mm)	Weight (g)
1	5/1/89			1000	75.44	75.40	75.57	75.47	6.505"	1021.56
2	5/1/89			1000	75.88	75.34	74.99	75.40	5.615"	962.21
3	5/1/89			1000	75.90	75.51	75.92	75.78	5.645"	964.87
4	5/1/89			1000	75.75	75.45	75.29	75.50	6.149"	1015.40
5	5/1/89			1000	75.56	75.62	86.12	79.10	6.210"	955.65
6	5/1/89			1000	86.12	86.12	86.12	86.12	143.35	972.94
7	5/1/89			1000	75.17	75.31	75.52	75.33	5.780"	980.80
8	5/1/89			1000	75.42	75.05	75.49	75.32	152.99	1000.25
9	5/1/89			1000	76.00	75.79	75.94	75.91	153.00	989.55
10	5/1/89			1000	75.76	75.82	75.77	75.78	153.00	1010.08
11	5/1/89			1000	75.85	75.87	75.97	75.90	152.99	1003.02
12	5/1/89			1000	76.05	75.96	75.95	75.99	153.04	1010.35
13	5/1/89			1000	75.83	75.91	75.83	75.86	153.05	1032.72
14	5/1/89			1000	75.87	75.77	75.96	75.87	153.01	1005.06
15	5/1/89			1000	75.77	75.96	75.80	75.84	153.03	977.57
16	5/1/89			1000	76.03	75.76	76.17	75.99	151.39	100.53
17	5/1/89			1000	75.94	75.82	75.87	75.88	137.29	945.71
18	5/1/89			1000	75.83	75.81	75.92	75.85	135.54	944.43
19	5/1/89			1000	75.67	75.83	75.57	75.69	151.35	1002.26
20	5/1/89			1000	75.68	75.81	75.90	75.80	146.04	979.11
21	5/1/89			1000	75.39	75.90	75.82	75.70	132.93	929.63
22	5/1/89			1000	75.77	75.74	76.07	75.86	153.10	1029.28
23	5/1/89			1000	75.75	75.85	75.72	75.77	136.49	924.03
24	5/1/89			1000	76.12	75.41	75.89	75.81	140.75	949.85
25	5/1/89			1000	75.80	75.76	75.88	75.81	134.81	925.57

Sample Number FLYASH	Date	Sonic Reading	Comments	Storage Pressure (psi)	Dia.1 (mm)	Dia.2 (mm)	Dia.3 (mm)	Avg. Dia. (mm)	Length (mm)	Weight (g)
45	2/2/89			0	75.87	75.95	76.05	75.96	132.03	934.28
52	2/2/89			0	76.28	76.18	75.89	76.12	136.74	949.00
53	2/2/89			0	75.98	75.98	76.49	76.15	146.17	1003.46
54	2/2/89			0	76.33	76.02	76.10	76.15	133.81	945.36
55	2/2/89			0	76.22	76.15	76.04	76.14	134.41	960.80
56	2/2/89			0	76.08	76.11	75.81	76.00	133.53	955.95
57	2/2/89			0	76.04	76.10	76.09	76.08	137.57	978.13
59	2/2/89			0	75.83	76.07	76.02	75.97	150.50	1024.59
60	2/2/89			0	76.10	76.18	76.22	76.17	144.42	1001.87
61	2/2/89			0	75.99	75.96	76.10	76.02	147.72	1017.00
63	2/2/89			0	76.16	76.26	76.07	76.16	133.45	941.02
65	2/2/89			0	75.88	76.23	75.91	76.01	152.74	1022.90
66	2/2/89			0	76.05	75.90	75.84	75.93	152.35	1021.86
67	2/2/89			0	76.71	76.16	76.02	76.30	137.20	1230.52
68	2/2/89			0	76.07	75.85	76.22	76.05	152.85	1053.84
69	2/2/89			0	75.94	75.84	75.90	75.89	137.16	956.54
70	2/2/89			0	75.96	75.91	75.97	75.95	135.75	960.21
71	2/2/89			0	75.52	75.85	75.72	75.70	152.79	1042.38
72	2/2/89			0	75.76	75.82	76.01	75.86	153.03	1043.20
73	2/2/89			0	75.89	76.04	76.00	75.98	135.55	957.98
74	2/2/89			0	76.02	75.68	75.87	75.86	148.51	1013.61
76	2/2/89			0	76.56	76.52	76.35	76.48	122.22	1268.00
77	2/2/89			0	76.04	76.17	75.96	76.06	152.82	1028.31
78	2/2/89			0	75.93	76.16	75.86	75.98	153.00	1074.52
79	2/2/89			0	76.00	75.79	75.96	75.92	152.75	1037.69

Sample Number FLYASH	Date	Sonic Reading	Comments	Storage Pressure (psi)	Dia.1 (mm)	Dia.2 (mm)	Dia.3 (mm)	Avg. Dia. (mm)	Length (mm)	Weight (g)
24	2/2/89			500	75.19	75.69	75.72	75.53	139.49	969.93
26	2/2/89			500	75.97	75.92	75.70	75.86	139.12	964.63
27	2/2/89			500	75.48	75.99	75.78	75.75	141.70	979.30
28	2/2/89			500	75.97	75.90	76.02	75.96	143.54	999.49
29	2/2/89			500	75.75	75.67	75.90	75.77	133.49	941.00
31	2/2/89			500	75.79	75.85	75.92	75.85	136.47	948.59
32	2/2/89			500	76.02	75.74	75.73	75.83	142.47	1002.39
33	2/2/89			500	75.86	75.56	75.96	75.79	140.24	984.25
34	2/2/89			500	76.04	75.85	75.95	75.95	140.08	991.58
35	2/2/89			500	75.64	75.56	75.89	75.70	152.93	1043.99
36	2/2/89			500	76.07	75.81	75.92	75.93	142.65	1000.77
39	2/2/89			500	75.97	75.79	75.83	75.86	134.67	952.60
40	2/2/89			500	76.10	75.78	75.98	75.95	147.14	1026.90
41	2/2/89			500	75.99	76.02	75.74	75.92	139.82	987.07
42	2/2/89			500	75.86	75.97	76.07	75.97	131.39	933.51
43	2/2/89			500	76.18	75.96	76.03	76.06	138.22	973.13
44	2/2/89			500	75.98	76.07	75.94	76.00	145.53	1015.21
46	2/2/89			500	75.32	76.16	76.09	75.86	133.30	944.83
47	2/2/89			500	75.98	76.04	75.96	75.99	137.99	964.39
49	2/2/89			500	76.13	76.16	76.13	76.14	135.66	1203.47
50	2/2/89			500	76.10	76.36	76.08	76.18	134.01	1214.25
62	2/2/89			500	75.96	75.88	75.96	75.93	141.44	983.54

Sample Number FLYASH	Date	Sonic Reading	Comments	Storage Pressure (psi)	Dia.1 (mm)	Dia.2 (mm)	Dia.3 (mm)	Avg. Dia. (mm)	Length (mm)	Weight (g)
1	2/2/89			1000	75.05	75.73	75.57	75.45	152.19	1051.32
2	2/2/89			1000	75.71	75.94	75.73	75.79	142.60	1000.75
3	2/2/89			1000	75.91	76.11	76.17	76.06	143.52	1005.72
4	2/2/89			1000	75.91	76.06	76.16	76.04	153.00	1078.83
5	2/2/89			1000	75.83	75.75	75.82	75.80	142.16	995.02
6	2/2/89			1000	75.95	76.01	75.73	75.90	153.05	1049.55
6	2/2/89			1000	75.91	75.82	75.99	75.91	144.63	1009.08
7	2/2/89			1000	75.80	75.97	75.76	75.84	146.28	1009.52
8	2/2/89			1000	75.54	75.75	75.68	75.66	152.27	1054.34
8	2/2/89			1000	75.69	75.72	75.90	75.77	141.99	998.31
10	2/2/89			1000	75.82	75.71	75.78	75.77	149.37	1035.35
12	2/2/89			1000	76.08	76.07	76.10	76.08	153.98	1069.04
13	2/2/89			1000	75.82	76.08	76.02	75.97	153.10	1081.83
14	2/2/89			1000	75.94	75.68	75.89	75.84	151.28	1035.07
15	2/2/89			1000	75.74	75.82	75.76	75.77	153.00	1034.32
16	2/2/89			1000	75.77	75.66	76.06	75.83	151.78	1049.09
17	2/2/89			1000	75.79	76.00	75.72	75.84	136.91	972.40
18	2/2/89			1000	75.83	76.16	76.05	76.01	135.90	972.73
19	2/2/89			1000	75.71	75.71	75.71	75.71	150.14	1030.24
20	2/2/89			1000	75.96	76.18	75.90	76.01	146.28	1018.27
22	2/2/89			1000	75.64	75.66	75.72	75.67	153.00	1078.44
23	2/2/89			1000	75.99	75.75	75.77	75.84	136.80	963.02
25	2/2/89			1000	75.82	75.66	75.86	75.78	131.48	953.18

Sample Number FLYASH	Date	Sonic Reading	Comments	Storage Pressure (psi)	Dia.1 (mm)	Dia.2 (mm)	Dia.3 (mm)	Avg. Dia. (mm)	Length (mm)	Weight (g)
45	31/3/89	2670	LT	0	75.89	75.65	75.58	75.71	150.36	948.50
52	31/3/89			0	76.07	76.12	76.12	76.10	135.17	963.60
55	31/3/89			0	75.78	75.71	75.72	75.74	134.11	973.90
56	31/3/89			0	75.77	75.73	75.50	75.67	134.70	971.70
58	31/3/89			0	76.13	76.15	76.01	76.10	129.50	1232.90
59	31/3/89	2840	LT	0	76.02	75.65	75.47	75.71	150.04	1040.50
61	31/3/89			0	76.09	75.06	75.55	75.57	146.88	1034.30
63	31/3/89			0	75.66	76.22	76.02	75.97	130.80	957.30
66	31/3/89			0	75.82	76.16	75.13	75.70	149.80	1035.50
67	31/3/89			0	75.89	75.87	75.81	75.86	132.09	1240.10
68	31/3/89	3067	CRUSHED	0	75.88	75.56	75.82	75.75	152.80	1070.00
69	31/3/89			0	75.99	75.04	75.77	75.60	134.71	968.80
70	31/3/89	3067	CRUSHED	0	75.99	75.69	76.27	53.32	135.20	973.90
71	31/3/89			0	75.61	76.03	75.94	75.86	153.00	1057.80
72	31/3/89			0	75.95	76.02	76.05	76.01	154.00	1060.30
73	31/3/89			0	75.81	75.78	75.56	75.72	135.40	972.20
74	31/3/89	2860	LT	0	75.57	74.98	75.20	75.25	148.81	1028.80
76	31/3/89	3082	LT	0	75.82	75.91	75.45	75.73	150.58	1040.20
77	31/3/89	3065	CRUSHED	0	75.12	75.78	75.35	75.42	151.80	1043.60
79	31/3/89			0	74.56	75.48	75.54	75.19	152.80	1052.10

Sample Number FLYASH	Date	Sonic Reading	Comments	Storage Pressure (psi)	Dia.1 (mm)	Dia.2 (mm)	Dia.3 (mm)	Avg. Dia. (mm)	Length (mm)	Weight (g)
24	30/3/89	2280	LT	500	75.56	76.10	76.26	75.97	139.56	978.50
26	30/3/89	2234	LT	500	75.23	75.52	75.52	75.42	137.94	971.40
27	30/3/89	2383	LT	500	70.47	70.50	70.70	70.56	134.98	986.10
28	30/3/89	2343	CRUSHED	500	75.96	76.03	75.67	75.89	142.61	1010.80
29	30/3/89	3982	LT	500	75.88	75.92	76.04	75.95	13.53	949.50
31	30/3/89	2268	LT	500	75.62	76.10	75.89	75.87	125.53	956.70
32	30/3/89			500	75.61	75.88	75.53	75.67	142.71	1011.70
33	30/3/89			500	75.95	75.66	75.93	75.85	140.01	995.40
34	30/3/89			500	76.01	75.82	75.78	75.87	140.10	1002.00
35	30/3/89	2446	LT	500	75.60	75.72	75.75	75.69	153.06	1049.70
36	30/3/89	2182	CRUSHED	500	76.09	75.98	75.85	75.97	143.09	1012.90
40	30/3/89		SPLIT	500	75.86	75.91	75.85	75.87	147.06	108.30
41	30/3/89			500	75.54	76.03	75.85	75.81	109.77	997.30
46	30/3/89		SPLIT	500	76.11	76.25	76.11	76.16	133.32	956.90
47	30/3/89	2266	CRUSHED	500	76.15	76.09	76.12	76.12	138.03	976.30
49	30/3/89			500	75.74	75.77	75.69	75.73	132.07	1210.90
50	30/3/89			500	75.68	76.08	75.89	75.88	131.08	1221.40

LT designates long term sonic test sample.

Sample Number FLYASH	Date	Sonic Reading	Comments	Storage Pressure (psi)	Dia.1 (mm)	Dia.2 (mm)	Dia.3 (mm)	Avg. Dia. (mm)	Length (mm)	Weight (g)
1	30/3/89	2218	LT	1000	75.75	75.56	75.90	75.74	152.86	1054.20
3	30/3/89			1000	76.21	75.79	75.99	76.00	143.34	1014.00
4	30/3/89			1000	75.19	75.99	75.91	75.70	154.00	1085.30
5	30/3/89	2730	CRUSHED	1000	75.88	76.15	75.99	76.01	142.25	1002.00
7	30/3/89	2316	LT	1000	85.82	75.39	75.93	79.05	146.11	1015.50
8	30/3/89	2228	LT	1000	75.76	75.51	75.80	75.69	152.78	1056.70
9	30/3/89			1000	75.88	76.03	75.84	75.92	154.00	1056.30
10	30/3/89			1000	75.83	75.58	75.76	75.72	148.89	1042.70
12	30/3/89		SPLIT	1000	76.05	76.20	75.95	76.07	152.81	1075.80
13	30/3/89	2397	CRUSHED	1000	75.72	75.83	75.91	75.82	154.00	1088.80
14	30/3/89	2297	LT	1000	75.94	75.80	76.01	75.92	152.19	1036.80
15	30/3/89			1000	75.84	75.81	75.36	75.67	152.85	1042.20
16	30/3/89		SPLIT	1000	75.81	75.87	75.83	75.84	151.37	1057.00
18	30/3/89	2180	CRUSHED	1000	75.96	75.97	75.95	75.96	143.11	1006.40
18A	30/3/89			1000	76.11	75.98	75.89	75.99	137.03	979.70
19	30/3/89	2111	LT	1000	75.76	75.85	75.83	75.81	148.82	1033.10
20	30/3/89			1000	75.81	76.12	75.67	75.87	145.69	1027.20
22	30/3/89			1000	75.61	75.78	76.01	75.80	154.00	1085.60

* F5 very difficult to get good reading *

LT designates long term sonic test sample.

Sample Number	Date	Sonic Reading	Comments	Storage Pressure (psi)	Dia.1 (mm)	Dia.2 (mm)	Dia.3 (mm)	Avg. Dia. (mm)	Length (mm)	Weight (g)
51	2/1/89			0	76.21	76.40	76.27	76.29	120.51	907.10
52	2/1/89			0	75.91	75.94	76.33	76.06	125.00	921.30
53	2/1/89			0	75.42	75.99	76.31	75.91	126.10	927.50
54	2/1/89			0	76.06	75.96	75.96	75.99	127.78	934.40
55	2/1/89			0	75.74	76.11	76.11	75.99	121.76	911.20
56	2/1/89			0	76.14	75.99	75.85	75.99	125.90	924.70
58	2/1/89			0	75.94	75.95	75.77	75.89	125.43	922.20
59	2/1/89			0	75.98	76.25	75.90	76.04	121.11	910.50
60	2/1/89			0	75.98	75.95	75.90	75.94	116.88	884.50
61	2/1/89			0	75.97	75.95	75.83	75.92	122.34	914.10
62	2/1/89			0	75.90	75.95	76.06	75.97	123.42	918.10
63	2/1/89			0	76.06	75.64	75.92	75.87	122.43	906.40
64	2/1/89			0	75.96	75.96	75.93	75.95	120.09	919.40
65	2/1/89			0	76.09	76.10	76.12	76.10	122.28	953.50
66	2/1/89			0	75.79	76.08	75.86	75.91	127.04	945.90
67	2/1/89			0	75.96	75.96	75.95	75.96	123.73	919.10
68	2/1/89			0	76.12	75.99	76.10	76.07	125.22	940.10
69	2/1/89			0	75.96	76.34	76.19	76.16	122.57	947.60
70	2/1/89			0	75.86	75.88	75.72	75.82	121.67	910.00
71	2/1/89			0	75.78	75.88	75.95	75.87	125.24	914.40
72	2/1/89		with core	0	75.96	76.38	75.96	76.10	126.90	1240.00
73	2/1/89		with core	0	76.30	75.90	75.84	76.01	122.45	1211.70

Sample Number	Date	Sonic Reading	Comments	Storage Pressure (psi)	Dia.1 (mm)	Dia.2 (mm)	Dia.3 (mm)	Avg. Dia. (mm)	Length (mm)	Weight (g)
26	2/1/89			500	75.92	75.91	75.88	75.90	129.34	945.45
27	2/1/89			500	76.00	75.68	75.94	75.87	125.65	934.10
28	2/1/89			500	76.01	75.88	75.93	75.94	123.99	933.30
29	2/1/89			500	76.21	75.96	75.94	76.04	121.08	946.40
30	2/1/89			500	75.94	75.85	76.59	76.13	122.44	922.70
31	2/1/89			500	76.02	76.44	75.87	76.11	122.17	963.70
32	2/1/89			500	75.81	75.85	75.78	75.81	120.68	927.10
33	2/1/89			500	76.07	76.03	75.93	76.01	119.39	900.90
34	2/1/89			500	75.64	75.77	75.83	75.75	123.43	928.60
35	2/1/89			500	75.23	76.10	76.28	75.87	125.24	918.90
36	2/1/89			500	75.87	75.61	76.17	75.88	122.06	921.15
37	2/1/89			500	76.10	75.93	75.87	75.97	121.15	912.10
38	2/1/89			500	75.71	75.89	75.79	75.80	121.82	914.80
39	2/1/89			500	75.92	76.06	75.89	75.96	121.92	908.50
40	2/1/89			500	75.72	75.85	75.77	75.78	120.45	907.90
41	2/1/89			500	75.68	76.04	75.05	75.59	122.68	921.10
42	2/1/89			500	75.89	76.01	75.93	75.94	121.99	925.80
43	2/1/89			500	76.30	75.63	75.96	75.96	124.81	991.50
44	2/1/89			500	76.20	76.01	75.84	76.02	120.33	903.10
45	2/1/89			500	76.17	76.14	75.95	76.09	121.01	951.10
46	2/1/89			500	75.82	75.78	75.85	75.82	128.99	941.00
47	2/1/89			500	76.36	76.10	76.56	76.34	120.35	939.90
48	2/1/89			500	75.89	75.88	75.94	75.90	128.80	945.50
49	2/1/89			500	75.98	76.35	75.81	76.05	123.67	913.10
50	2/1/89			500	75.87	75.84	76.02	75.91	125.77	927.00
57	2/1/89			500	75.98	76.14	76.03	76.05	126.02	932.80

Sample Number	Date	Sonic Reading	Comments	Storage Pressure (psi)	Dia.1 (mm)	Dia.2 (mm)	Dia.3 (mm)	Avg. Dia. (mm)	Length (mm)	Weight (g)
1	2/1/89			1000	75.88	75.95	76.50	76.11	124.01	936.6
2	2/1/89			1000	75.94	76.24	76.10	76.09	124.01	951.1
3	2/1/89			1000	75.97	76.05	76.35	76.12	122.35	929.5
4	2/1/89			1000	75.80	75.93	75.79	75.84	122.37	927.7
5	2/1/89			1000	76.13	76.31	75.80	76.08	123.83	913.50
6	2/1/89			1000	76.10	75.95	75.72	75.92	123.45	928.70
7	2/1/89			1000	75.87	76.63	76.20	76.23	119.45	911.30
8	2/1/89			1000	76.07	76.30	75.82	76.06	131.85	959.00
9	2/1/89			1000	75.99	76.12	75.96	76.02	122.53	919.20
10	2/1/89			1000	75.91	75.91	75.85	75.89	128.84	950.70
11	2/1/89			1000	76.04	76.30	75.83	76.06	121.49	907.80
12	2/1/89			1000	76.13	76.17	75.90	76.07	127.12	935.30
13	2/1/89			1000	75.89	76.05	75.91	75.95	121.77	922.80
14	2/1/89			1000	76.14	75.89	75.88	75.97	129.22	949.00
15	2/1/89			1000	75.82	75.91	75.87	75.87	118.75	896.00
16	2/1/89			1000	75.66	75.95	75.72	75.78	128.79	946.10
17	2/1/89			1000	75.67	75.73	76.03	75.81	128.63	951.14
18	2/1/89			1000	76.20	75.96	76.08	76.08	121.56	919.50
19	2/1/89			1000	75.77	75.75	76.09	75.87	127.62	934.90
20	2/1/89			1000	75.94	75.96	75.97	75.96	123.16	928.60
21	2/1/89			1000	75.90	75.04	76.16	75.70	127.13	947.80
22	2/1/89			1000	75.82	76.00	76.20	76.01	126.20	992.30
23	2/1/89			1000	76.59	75.61	75.99	76.06	120.65	910.80
24	2/1/89			1000	76.29	76.32	76.09	76.23	124.65	955.00
25	2/1/89			1000	75.92	75.91	75.88	75.90	125.36	930.70

Sample Number	Date	Sonic Reading	Comments	Storage Pressure (psi)	Dia.1 (mm)	Dia.2 (mm)	Dia.3 (mm)	Avg. Dia. (mm)	Length (mm)	Weight (g)
52	2/2/89		Kept in	0	76.35	76.12	76.37	76.28	125.87	930.41
53	2/2/89		yellow	0	76.47	76.33	76.15	76.32	126.16	939.37
54	2/2/89		container	0	76.38	76.22	76.50	76.37	127.25	946.20
56	2/2/89			0	76.38	76.28	76.12	76.26	125.51	938.54
58	2/2/89			0	76.24	76.65	76.57	76.49	124.98	936.36
59	2/2/89			0	76.35	76.24	76.45	76.35	121.82	924.45
60	2/2/89			0	76.09	76.47	76.13	76.23	114.75	882.22
61	2/2/89			0	76.15	76.24	76.36	76.25	123.10	927.42
62	2/2/89			0	76.28	76.56	76.43	76.42	121.25	910.19
63	2/2/89			0	76.39	76.28	76.50	76.39	122.82	922.21
64	2/2/89			0	76.30	76.46	76.31	76.36	120.88	931.38
65	2/2/89			0	76.25	76.56	76.36	76.39	121.50	953.70
72	2/2/89			0	75.36	75.87	75.88	75.70	153.00	1043.94
73	2/2/89			0	76.46	76.39	76.45	76.43	119.15	1239.20

Sample Number	Date	Sonic Reading	Comments	Storage Pressure (psi)	Dia.1 (mm)	Dia.2 (mm)	Dia.3 (mm)	Avg. Dia. (mm)	Length (mm)	Weight (g)
26	2/2/89			500	76.06	76.48	76.05	76.20	129.43	956.12
27	2/2/89			500	76.70	76.81	76.03	76.51	124.75	939.41
28	2/2/89			500	76.12	76.28	76.49	76.30	125.20	940.77
29	2/2/89			500	76.16	76.43	76.35	76.31	121.47	754.22
30	2/2/89			500	76.25	76.26	76.55	76.35	12.31	932.46
31	2/2/89			500	76.44	76.43	76.19	76.35	123.82	971.80
32	2/2/89			500	75.90	76.10	76.05	76.02	120.79	931.93
33	2/2/89			500	76.39	76.01	76.98	76.46	120.43	907.22
34	2/2/89			500	76.01	76.61	76.26	76.29	123.42	917.61
34	2/2/89			500	75.99	76.78	76.20	76.32	124.16	937.26
35	2/2/89			500	76.06	76.35	76.43	76.28	125.00	930.05
36	2/2/89			500	76.16	76.35	76.52	76.34	129.40	955.87
36	2/2/89			500	76.29	76.13	76.40	76.27	122.29	930.45
37	2/2/89			500	76.25	76.30	76.13	76.23	120.35	912.55
38	2/2/89			500	76.69	76.08	76.40	76.39	116.70	914.24
39	2/2/89			500	76.08	76.48	76.31	76.29	123.91	923.28
40	2/2/89			500	76.18	76.65	76.65	76.26	120.98	917.53
41	2/2/89			500	75.24	75.92	75.94	76.03	121.28	923.90
42	2/2/89			500	76.30	76.44	76.43	76.39	122.60	936.40
43	2/2/89			500	76.44	76.55	76.84	76.61	123.29	992.41
44	2/2/89			500	76.21	76.22	76.47	76.30	120.32	910.67
45	2/2/89			500	6.23	76.53	76.40	53.05	121.08	964.32
47	2/2/89			500	76.62	76.76	76.22	76.53	117.80	927.35
48	2/2/89			500	76.39	76.11	76.07	76.19	124.71	937.01
50	2/2/89			500	76.20	76.26	76.18	76.21	127.02	936.85
57	2/2/89			500	76.11	76.34	76.03	76.16	118.48	9505.29

Sample Number	Date	Sonic Reading	Comments	Storage Pressure (psi)	Dia.1 (mm)	Dia.2 (mm)	Dia.3 (mm)	Avg. Dia. (mm)	Length (mm)	Weight (g)
1	2/2/89			1000	76.11	76.26	76.49	76.29	124.01	939.30
2	2/2/89			1000	76.10	76.38	76.09	76.19	126.00	955.68
3	2/2/89			1000	76.31	76.32	76.11	76.25	123.47	933.99
4	2/2/89			1000	76.12	76.04	76.24	76.13	123.08	933.63
5	2/2/89			1000	76.06	76.10	76.02	76.06	119.22	967.03
6	2/2/89			1000	75.83	75.87	76.23	75.98	119.93	908.84
7	2/2/89			1000	75.90	76.12	76.20	76.07	120.15	916.83
8	2/2/89			1000	76.02	76.23	76.15	76.13	132.59	967.12
9	2/2/89			1000	76.27	76.47	76.37	76.37	123.36	929.35
10	2/2/89			1000	76.02	76.00	75.87	75.96	124.00	934.99
11	2/2/89			1000	75.92	76.10	76.11	76.04	120.52	903.88
12	2/2/89			1000	76.19	76.47	76.37	76.34	127.43	942.52
13	2/2/89			1000	76.37	76.48	76.11	76.32	120.84	926.62
14	2/2/89			1000	76.11	76.29	76.37	76.26	130.04	955.78
15	2/2/89			1000	75.88	76.07	76.03	75.99	117.09	886.40
16	2/2/89			1000	76.31	76.12	76.52	76.32	131.03	958.99
17	2/2/89			1000	76.45	76.18	76.18	76.27	129.20	957.92
18	2/2/89			1000	76.39	76.03	76.16	76.19	118.98	908.81
19	2/2/89			1000	76.35	76.33	76.14	76.27	128.24	942.44
20	2/2/89			1000	76.30	76.44	76.24	76.33	123.51	941.07
21	2/2/89			1000	76.12	76.27	76.40	76.26	129.78	957.63
22	2/2/89			1000	76.31	76.35	76.42	76.36	126.56	1000.26
23	2/2/89			1000	75.98	75.94	76.09	76.00	119.99	907.16
24	2/2/89			1000	76.38	76.47	76.02	76.29	124.55	957.44
25	2/2/89			1000	76.37	75.97	76.24	76.19	127.09	940.75

Sample Number	Date	Sonic Reading	Comments	Storage Pressure (psi)	Dia.1 (mm)	Dia.2 (mm)	Dia.3 (mm)	Avg. Dia. (mm)	Length (mm)	Weight (g)
52	31/3/89	2300	CRUSHED	0	76.49	75.98	75.76	76.08	125.93	939.30
54	31/3/89			0	75.86	76.18	75.80	75.95	134.27	960.00
56	31/3/89	2210	CRUSHED	0	75.69	76.81	76.15	76.22	126.01	947.20
58	31/3/89			0	76.28	77.06	76.28	76.54	125.19	946.10
60	31/3/89	2470	CRUSHED	0	76.19	75.94	75.79	75.97	115.49	893.80
62	31/3/89	2370	LT	0	75.20	75.77	76.08	75.68	120.11	911.90
64	31/3/89			0	76.49	76.77	76.24	76.50	120.38	939.30
65	31/3/89	2437	LT	0	75.84	76.78	76.59	76.40	120.56	957.50
72	31/3/89			0	76.69	76.52	75.92	76.38	125.92	1258.40
73	31/3/89			0	76.17	76.60	76.29	76.35	122.84	1230.30

Sample Number	Date	Sonic Reading	Comments	Storage Pressure (psi)	Dia.1 (mm)	Dia.2 (mm)	Dia.3 (mm)	Avg. Dia. (mm)	Length (mm)	Weight (g)
27	30/3/89			500	76.06	76.41	76.20	76.22	124.74	942.40
28	30/3/89			500	76.54	76.38	76.95	76.62	124.26	943.70
30	30/3/89			500	76.52	76.09	76.19	76.27	123.16	935.90
31	30/3/89		SPLIT	500	76.56	76.38	76.32	76.42	124.30	974.20
32	30/3/89			500	76.20	76.71	76.13	76.35	120.90	929.40
33	30/3/89			500	76.31	76.27	76.05	76.21	121.14	910.40
34	30/3/89	2270	CRUSHED	500	76.20	76.45	76.35	76.33	124.46	919.70
34A	30/3/89			500	76.08	76.21	76.32	76.20	123.64	938.40
35	30/3/89		SPLIT	500	76.40	76.55	76.17	76.37	124.89	932.30
36	30/3/89			500	75.24	76.36	76.08	75.89	122.80	933.70
37	30/3/89	2181	LT	500	76.19	76.33	76.67	76.40	120.47	908.40
38	30/3/89	2189	LT	500	75.72	76.37	76.04	76.04	120.12	914.20
41	30/3/89	3380	LT	500	76.70	76.49	76.63	76.61	121.71	921.40
42	30/3/89			500	76.47	76.53	76.20	76.40	123.17	939.50
43	30/3/89	2236	LT	500	75.41	75.69	75.77	75.62	123.54	992.90
44	30/3/89			500	76.41	76.36	76.24	76.34	119.97	909.80
45	30/3/89	2278	CRUSHED	500	76.87	76.40	76.97	76.75	121.69	967.60
47	30/3/89			500	76.84	75.61	75.92	76.12	119.52	932.10
48	30/3/89	2430	LT	500	76.17	76.52	76.18	76.29	124.93	954.00
50	30/3/89	2738	CRUSHED	500	76.53	76.84	76.73	76.70	126.95	942.10
51	30/3/89			500	76.35	75.74	76.34	76.14	119.25	905.90

Sample Number	Date	Sonic Reading	Comments	Storage Pressure (psi)	Dia.1 (mm)	Dia.2 (mm)	Dia.3 (mm)	Avg. Dia. (mm)	Length (mm)	Weight (g)
1	30/3/89	2300	LT	1000	76.29	76.28	76.25	76.27	124.69	940.10
2	30/3/89			1000	76.25	76.33	76.31	76.30	126.12	954.50
3	30/3/89			1000	76.23	76.86	76.31	76.47	124.41	934.10
5	30/3/89	2440	LT	1000	76.13	76.37	76.30	76.27	119.27	904.10
6	30/3/89	2400	LT	1000	75.94	76.23	75.99	76.05	118.97	905.60
8	30/3/89			1000	75.96	76.10	75.99	76.02	130.85	966.50
9	30/3/89	2326	CRUSHED	1000	75.98	76.21	76.20	76.13	122.76	929.00
10	30/3/89			1000	75.38	76.25	75.85	75.83	123.76	934.90
11	30/3/89	2530	LT	1000	76.12	75.75	76.19	76.02	120.52	901.00
12	30/3/89			1000	76.43	76.70	75.96	76.36	126.68	942.40
13	30/3/89	2240	CRUSHED	1000	76.16	76.37	76.36	76.30	121.14	928.00
15	30/3/89	2397	LT	1000	76.18	76.13	76.24	76.18	116.69	884.00
16	30/3/89			1000	76.31	76.27	76.30	76.29	129.40	958.30
18	30/3/89	2180	LT	1000	76.15	76.37	75.87	76.13	118.83	907.40
19	30/3/89			1000	76.21	76.16	76.51	76.29	127.78	943.90
20	30/3/89			1000	76.30	76.67	76.62	76.53	124.05	942.00
21	30/3/89			1000	76.58	76.25	75.77	76.20	128.87	957.20
23	30/3/89	2450	LT	1000	76.00	76.00	75.88	75.96	119.41	905.30
24	30/3/89	3070	CRUSHED	1000	76.03	76.13	76.15	76.10	123.57	958.10
25	30/3/89			1000	76.41	76.53	76.38	76.44	126.72	941.00

Sample Number FLYASH	Date	Storage Pressure (psi)	Dia. 1 (mm)	Dia. 2 (mm)	Dia. 3 (mm)	Avg. Dia. (mm)	Length (mm)	Weight (g)
45	24/11/89	0	75.83	75.84	75.91	75.86	132.57	953.11
52	24/11/89		75.91	75.68	75.88	75.82	135.22	961.19
54	24/11/89		75.74	[illegible]	75.99	75.90	134.47	955.5
55	24/11/89		75.63	75.84	76.04	75.84	134.9	969.97
56	24/11/89		75.76	75.78	75.87	75.80	135.12	967.23
58	24/11/89	0	76.51	76.33	76.4	76.41	128.72	1226.31
59	24/11/89		74.92	75.96	75.91	75.60	150.22	1043.76
61	24/11/89		75.59	75.99	75.86	75.81	147.33	1028.77
63	24/11/89		75.59	75.71	76.95	76.08	131.45	952.57
66	24/11/89		76.03	75.9	75.65	75.86	146	1035.18
67	24/11/89		75.97	75.96	75.92	75.95	134.19	1235.33
69	24/11/89	0	75.74	75.91	75.68	75.78	134.53	965.69
73	24/11/89		75.59	75.77	75.55	75.64	134.23	969.83
74	24/11/89		75.84	75.66	75.29	75.60	150.09	1034.94
76	24/11/89		76.15	75.95	76.6	76.23	151.21	1042.53
79	24/11/89	0	75.97	76.12	76.07	76.05	152.71	1049.01

TANK #2

Sample Number FLYASH	Date	Storage Pressure (psi)	Dia. 1 (mm)	Dia. 2 (mm)	Dia. 3 (mm)	Avg. Dia. (mm)	Length (mm)	weight (g)
24	24/11/89	500	75.88	75.98	76.02	75.96	138.61	968.53
26	24/11/89		76.14	76.04	75.95	76.04	139.11	961.35
27	24/11/89		76.03	76.05	76.18	76.09	142.26	976.07
29	24/11/89		75.97	76.15	75.82	75.98	133.19	940.63
31	24/11/89	500	75.77	76.08	76.15	76.00	135.29	947.26
32	24/11/89		75.79	75.87	75.73	75.80	142	998.87
33	24/11/89		75.91	75.96	75.93	75.93	140.03	982.2
34	24/11/89		75.98	75.98	76.04	76.00	141.84	989.05
35	24/11/89		76.05	75.96	75.79	75.93	152.28	1029.59
41	24/11/89		75.86	75.86	76	75.91	140.94	985.56
49	24/11/89		75.92	75.92	79.3	77.05	135.77	1200.49
50	24/11/89	500	75.99	76.1	76.22	76.10	134.89	1210.93

TANK #3

Sample Number FLYASH	Date	Storage Pressure (psi)	Dia. 1 (mm)	Dia. 2 (mm)	Dia. 3 (mm)	Avg. Dia. (mm)	Length (mm)	Weight (g)
1	24/11/89	1000	75.56	75.53	75.88	75.66	152.93	1038.86
3	24/11/89		75.86	75.84	75.81	75.84	143.42	996.83
4	24/11/89		75.95	75.97	75.86	75.93	155.41	1062.42
7	24/11/89		76.15	76.04	75.49	75.89	146.31	1001.98
8	24/11/89		75.96	75.71	75.41	75.69	151.87	1039.3
9	24/11/89		76.04	75.78	75.73	75.85	153	1033.57
10	24/11/89	1000	75.87	75.98	75.83	75.89	150.53	1023.23
14	24/11/89		76.17	75.41	76.03	75.87	149.09	1017.38
15	24/11/89		75.74	75.77	75.77	75.76	152.95	1021.69
18	24/11/89		75.78	75.95	76.04	75.92	135.87	969.78
19	24/11/89		75.89	75.74	75.89	75.84	150.41	1017.66
20	24/11/89		75.31	76.16	76.17	75.88	145.91	1012.04
22	24/11/89	1000	76.3	76.07	76.06	76.14	154	1065.53

Sample Number	Date	Storage Pressure (psi)	Dia. 1 (mm)	Dia. 2 (mm)	Dia. 3 (mm)	Avg. Dia. (mm)	Length (mm)	Weight (g)
[illegible]	[illegible]/11/89	0	76.85	76.95	76.93	76.91	120.84	920.12
65	24/11/89		76.62	77.38	77.19	77.06	120.72	963.09
72	24/11/89		76.81	76.76	77.12	76.90	124.63	1260
73	24/11/89	0	76.85	76.83	76.99	76.89	120.44	1234.18

Sample Number	Date	Storage Pressure (psi)	Dia. 1 (mm)	Dia. 2 (mm)	Dia. 3 (mm)	Avg. Dia. (mm)	Length (mm)	Weight (g)
27	24/11/89	500	76.56	76.56	76.61	76.58	125.13	946.01
28	24/11/89		77.1	76.97	76.65	76.91	124.67	948.07
30	24/11/89		76.63	76.97	76.62	76.74	123.46	941.49
32	24/11/89		76.46	77.21	76.49	76.72	121.35	938.96
33	24/11/89		76.51	76.57	76.27	76.45	120.77	914.53
34	24/11/89		76.37	76.85	76.72	76.65	124.81	943.46
36	24/11/89		76.58	77.15	76.6	76.78	122.09	937.02
37	24/11/89	500	76.32	76.86	76.89	76.69	121.03	916.33
38	24/11/89		76.81	77.31	76.77	76.96	118.45	919.47
41	24/11/89		76.93	77.32	76.54	76.93	121.86	928.85
42	24/11/89		76.51	77.13	76.74	76.79	123.68	943.85
43	24/11/89		76.69	77.12	76.74	76.85	124.49	999.56
44	24/11/89		76.64	77.04	76.88	76.85	120.35	918.82
47	24/11/89		76.59	77.22	76.51	76.77	118.28	937.86
48	24/11/89		76.66	76.68	76.75	76.70	125.15	943.08
51	24/11/89	500	76.44	76.9	76.73	76.69	119.06	915.23

Sample Number	Date	Storage Pressure (psi)	Dia. 1 (mm)	Dia. 2 (mm)	Dia. 3 (mm)	Avg. Dia. (mm)	Length (mm)	Weight (g)
1	24/11/89	1000	76.75	76.72	76.78	76.75	124.51	943.61
2	24/11/89		76.58	76.76	76.74	76.69	126.55	958.49
3	24/11/89		76.66	76.68	76.56	76.63	124.62	938.92
5	24/11/89		76.53	76.88	76.73	76.71	120.33	903.43
6	24/11/89		76.59	76.75	76.52	76.62	119.7	906.41
8	24/11/89		76.59	76.31	76.36	76.42	132.42	971.03
10	24/11/89		76.38	76.63	76.78	76.60	125.1	933.47
11	24/11/89	1000	76.83	76.72	76.54	76.70	120.92	904.84
12	24/11/89		76.72	76.82	76.48	76.67	128.26	945.42
15	24/11/89		76.43	76.74	77.08	76.75	117.47	882.9
16	24/11/89		76.79	76.99	76.91	76.90	131.17	962.77
18	24/11/89		[illegible]	[illegible].05	76.43	76.70	119.61	910.65
21	24/11/89		76.55	76.66	76.61	76.61	130.9	961.51
23	24/11/89		76.46	76.62	76.5	76.53	128.86	908.44
25	24/11/89	1000	76.65	76.83	76.92	76.80	127.49	944.06

Cylinder Splitting

February 8, 1989.

Storage Pressure (psi)	Sample Number		Splitting Load (kN)
1000	F23		53
	F17		48
		22	109
		17	57
500	F43		47
	F39		37
		49	56
		40	57
0	F78		54
	F53		46
		63	44
		59	77
		53	61

February 7, 1989 compression testing

Sample Number	Storage Pressure	Sonic Reading	E-Modulus (MPa)	Ultimate Load (kN)
C61	0	2200	2189	8.4
C54	0	2125	1871	7.4
C46	500	2465	3068	8
C29	500	2080	4400	10.9
C26	500	2390	2631	7.5
C4	1000	2305	2510	10
C7	1000	1950	1950	10.5
C14	1000	2370	1946	5.8
F57	0	2390	1402	12
F60	0	2390	1174	9.3
F63	0	2230	891	6.4
F62	500	2360	1073	8.5
F42	500	2270	1473	10.7
F44	500	2285	1335	7.8
F2	1000	2310	1168	6.5
F25	1000	2425	1687	9.4
F6	1000	2320	9385	9.4

Compression Testing

Date: February 7, 1989.

Sample No. C54
Storage Pressure (psi) 0

Sonic Reading 2125

Cylinder Area 0.004580 m^2

Load lb.	kN	Stress (kPa)	Defln. in.	Strain
1		218.3244	0.0003	0.000075
2		436.6489	0.0009	0.000225
3		654.9734	0.0014	0.00035
4		873.2979	0.0019	0.000475
5		1091.622	0.0024	0.0006
6		1309.946	0.003	0.00075
7		1528.271	0.0036	0.0009
7.4		1615.601	0.0039	0.000975
	2.96	646.2404		

E MODULUS (MPa) 1871.352

Compression Testing

Date: February 7, 1989.

Sample No. 61
Storage Pressure (psi) 0

Sonic Reading 2200

Cylinder Area 0.004566 m^2

Load lb.	kN	Stress (kPa)	Defln. in.	Strain
1		218.9930	0.0002	0.00005
2		437.9861	0.0007	0.000175
3		656.9792	0.0011	0.000275
4		875.9723	0.0016	0.0004
5		1094.965	0.0022	0.00055
6		1313.958	0.0027	0.000675
7		1532.951	0.0032	0.0008
8		1751.944	0.0039	0.000975
8.4		1839.542	0.0044	0.0011
	3.36	735.8168		

E MODULUS (MPa) 2189.930

Compression Testing

Date: February 7, 1989.

Sample No.	46
Storage Pressure (psi)	500

Sonic Reading 2465

Cylinder Area 0.004577 m^2

Load lb.	kN		Defln. in.	Strain
500	2.22	485.8505	0.0009	0.00015
1000	4.45	971.7010	0.0019	0.000316
1500	6.67	1457.551	0.0031	0.000516
1800	8.01	1749.061	0.0052	0.000866
720	3.20	699.6247		

E MODULUS (MPa) 3068.529

Compression Testing

Date: February 7, 1989.

Sample No. 29
Storage Pressure (psi) 500

Sonic Reading 2080

Cylinder area: 0.004573 m^2

Load lb.	kN	Stress (kPa)	Defln. in.	Strain
449.6402	2	437.2595	0.0003	0.000075
674.4604	3	655.8892	0.0005	0.000125
899.2805	4	874.5190	0.0007	0.000175
1124.100	5	1093.148	0.001	0.00025
1348.920	6	1311.778	0.0013	0.000325
1573.741	7	1530.408	0.0017	0.000425
1798.561	8	1749.038	0.0021	0.000525
2023.381	9	1967.667	0.0025	0.000625
2450.539	10.9	2383.064	0.0028	0.0007
	4.36	953.2257		

E MODULUS (MPa) 4372.595

Compression Testing

Date: February 7, 1989.

Sample No. C26
Storage Pressure (psi) 500

Sonic Reading 2390

Cylinder Area 0.004559 m^2

Load lb.	kN	Stress (psi)	Stress (kPa)	Defln. in.	Strain
449.6402	2	98606.01	438.5995	0.0006	0.00015
674.4604	3	147909.0	657.8993	0.001	0.00025
899.2805	4	197212.0	877.1990	0.0018	0.00045
1124.100	5	246515.0	1096.498	0.0024	0.0006
1348.920	6	295818.0	1315.798	0.0029	0.000725
1686.151	7.5	369772.5	1644.748	0.0034	0.00085

674.4604 3 657.8993

E MODULUS (MPa) 2631.597

Compression Testing

Date: February 7, 1989.

Sample No. 7
Storage Pressure (psi) 1000

Sonic Reading 1950

Cylinder Area 0.004517 m^2

Load lb.	kN	Stress (kPa)	Defln. in.	Strain
224.8201	1	221.3478	0.0002	0.00005
449.6402	2	442.6956	0.0005	0.000125
674.4604	3	664.0435	0.0008	0.0002
899.2805	4	885.3913	0.0011	0.000275
1124.100	5	1106.739	0.0015	0.000375
1348.920	6	1328.087	0.0019	0.000475
1573.741	7	1549.434	0.0022	0.00055
1798.561	8	1770.782	0.0027	0.000675
2023.381	9	1992.130	0.0032	0.0008
2248.201	10	2213.478	0.0036	0.0009
2360.611	10.5	2324.152	0.0039	0.000975
2360.611	10.5	2324.152	0.004	0.001
	4.2	929.6609		

E MODULUS (MPa) 2951.304

Compression Testing

Date: February 7, 1989.

Sample No. 4
Storage Pressure (psi) 1000

Sonic Reading 2305

Cylinder Area 0.004552

Load lb.	kN		Stress (kPa)	Defln. in.	strain
224.8201		1	219.6647	0.0002	0.00005
449.6402		2	439.3295	0.0005	0.000125
674.4604		3	658.9943	0.001	0.00025
899.2805		4	878.6591	0.0014	0.00035
1124.100		5	1098.323	0.0017	0.000425
1348.920		6	1317.988	0.0022	0.00055
1573.741		7	1537.653	0.0026	0.00065
1798.561		8	1757.318	0.0031	0.000775
2023.381		9	1976.983	0.0035	0.000875
2248.201		10	2196.647	0.0041	0.001025
2248.201		10	2196.647	0.0047	0.001175
		4	878.6591		

E MODULUS (MPa) 2510.454

Compression Testing

Date: February 7, 1989.

Sample No. 14
Storage Pressure (psi) 1000

Sonic Reading 2370

Cylinder Area 0.004567 m^2

Load lb.	kN		Defln. in.	Strain
224.8201	1	218.9548	0.0004	0.0001
449.6402	2	437.9096	0.00085	0.000212
674.4604	3	656.8644	0.00135	0.000337
899.2805	4	875.8192	0.0018	0.00045
1124.100	5	1094.774	0.0023	0.000575
1303.956	5.8	1269.937	0.0028	0.0007
521.5827	2.32	507.9751		

E MODULUS (MPa) 1946.264

Compression Testing

Date: February 7, 1989.

Sample No. F63
Storage Pressure (psi) 0

Sonic Reading 2230

Cylinder Area 0.004488 m^2

Load lb.	kN	Stress kPa	Defln. in.	Strain
1		222.7750	0.0006	0.00015
2		445.5500	0.0018	0.00045
3		668.3251	0.003	0.00075
4		891.1001	0.0045	0.001125
5		1113.875	0.0065	0.001625
6		1336.650	0.0089	0.002225
6.4		1425.760	0.01	0.0025
	2.56	570.3040		

E MODULUS (MPa) 891.1001

Compression Testing

Date: February 7, 1989.

Sample No. F60
Storage Pressure (psi) 0

Sonic Reading 2390

Cylinder Area 0.004539 m^2

Load lb.	kN	Stress (kPa)	Defln. in.	Strain
2		440.5631	0.0013	0.000325
3		660.8447	0.0021	0.000525
4		881.1263	0.003	0.00075
5		1101.407	0.0043	0.001075
6		1321.689	0.0055	0.001375
7		1541.971	0.0068	0.0017
8		1762.252	0.0084	0.0021
9.3		2048.618	0.0092	0.0023
3.72		819.4475		

E MODULUS (MPa) 1174.835

Compression Testing

Date: February 7, 1989.

Sample No. F57
Storage Pressure (psi) 0

Sonic Reading 2390

Cylinder area 0.004530 m^2

Load lb.	kN	Stress (kPa)	Defln. in.	Strain
500	2.22	490.8527	0.0012	0.0003
1000	4.45	981.7054	0.0027	0.000675
1500	6.67	1472.558	0.0042	0.00105
2000	8.90	1963.410	0.0061	0.001525
2500	11.12	2454.263	0.0088	0.0022
2700	12.01	2650.604	0.0101	0.002525
	4.80	1060.241		

E MODULUS (MPa) 1402.436

Compression Testing

Date: February 7, 1989.

Sample No. F44
Storage Pressure (psi) 500

Sonic Reading 2285

Cylinder Area 0.004493 m^2

Load lb.	kN	Stress (kPa)	Defln. in.	Strain
1		222.5591	0.0004	0.0001
2		445.1182	0.0012	0.0003
3		667.6773	0.002	0.0005
4		890.2364	0.0029	0.000725
5		1112.795	0.0038	0.00095
6		1335.354	0.005	0.00125
7		1557.913	0.0063	0.001575
7.8		1735.960	0.0078	0.00195
	3.12	694.3843		

E MODULUS (MPa) 1335.354

Compression Testing

Date: February 7, 1989.

Sample No. F62
Storage Pressure (psi) 500

Sonic Reading 2360

Cylinder Area 0.004518 m^2

Load lb.	kN	Stress (kPa)	Defln. in.	Strain
1		221.3089	0.0004	0.0001
2		442.6178	0.0013	0.000325
3		663.9268	0.0022	0.00055
4		885.2357	0.0033	0.000825
5		1106.544	0.0044	0.0011
6		1327.853	0.0058	0.00145
7		1549.162	0.0075	0.001875
8		1770.471	0.0094	0.00235
8.5		1881.125	0.012	0.003
3.4		752.4503		

E MODULUS (MPa) 1073.013

Compression Testing

Date: February 7, 1989.

Sample No. F42
Storage Pressure (psi) 500

Sonic Reading 2270

Cylinder Area 0.004524 m^2

Load lb.	kN	Stress (kPa)	Defln. in.	Strain
1		220.9980	0.0005	0.000125
2		441.9960	0.001	0.00025
3		662.9941	0.0016	0.0004
4		883.9921	0.0022	0.00055
5		1104.990	0.003	0.00075
6		1325.988	0.0036	0.0009
7		1546.986	0.0043	0.001075
8		1767.984	0.0051	0.001275
9		1988.982	0.0056	0.0014
10		2209.980	0.0061	0.001525
			0.0071	0.001775
10.7		2364.679	0.009	0.00225
4.28		945.8716		

E MODULUS (MPa) 1473.320

Compression Testing

Date: February 7, 1989.

Sample No. F25
Storage Pressure (psi) 1000

Sonic Reading 2425

Cylinder Area 0.004514 m^2

Load lb.	kN	Stress (kPa)	Defln. in.	Strain
1		221.5230	0.0003	0.000075
2		443.0461	0.0009	0.000225
3		664.5691	0.0015	0.000375
4		886.0922	0.0021	0.000525
5		1107.615	0.0028	0.0007
6		1329.138	0.0035	0.000875
7		1550.661	0.0042	0.00105
8		1772.184	0.005	0.00125
9		1993.707	0.006	0.0015
	9.4	2082.316	0.0068	0.0017
	3.76	832.9266		

E MODULUS (MPa) 1687.794

Compression Testing

Date: February 7, 1989.

Sample No. F6
Storage Pressure (psi) 1000

Sonic Reading 2320

Cylinder Area 0.000501 m^2

Load lb.	kN	Stress (kPa)	Defln. in.	Strain
1		1994.408	0.0006	0.00015
2		3988.817	0.002	0.0005
3		5983.226	0.0024	0.0006
4		7977.635	0.0034	0.00085
5		9972.044	0.0044	0.0011
6		11966.45	0.0055	0.001375
7		13960.86	0.007	0.00175
8		15955.27	0.0086	0.00215
9		17949.68	0.0105	0.002625
	9.4	18747.44	0.0114	0.00285
	3.76	7498.977		

E MODULUS (MPa) 9385.453

Compression Testing

Date: February 7, 1989.

Sample No. F2
Storage Pressure (psi) 1000

Sonic Reading 2310

Cylinder Area 0.004465 m^2

Load lb.	kN	Stress (kPa)	Defln. in.	Strain
224.8201	1	223.9386	0.0009	0.000225
674.4604	3	671.8159	0.0023	0.000575
899.2805	4	895.7545	0.0033	0.000825
1124.100	5	1119.693	0.0045	0.001125
1461.330	6.5	1455.601	0.0057	0.001425
	2.6	582.2404		

E MODULUS (MPa) 1168.375

Cylinder Splitting

30 March, 1989.

Storage Pressure (psi)	Sample Number	Splitting Load (lb.)
1000	20	1640
1000	19	560
1000	F16	2180
1000	F12	3000
500	31	2100
500	35	1640
500	F46	2760
500	F40	2630
0	58	1500
0	64	2040
0	F72	3600
0	F71	4140

April 4, 1989 compression testing

Sample Number	Storage Pressure	Sonic Reading	E-Modulus (MPa)	Ultimate Load (kN)
24	1000	3070	3040	10.4
13	1000	2240	2630	11.5
9	1000	2326	1410	12.0
F13	1000	2397	1390	12.6
F5	1000	2730	2200	15.0
F18	1000	2180	2210	16.9
34	500	2270	1750	8.9
45	500	2278	3380	9.6
50	500	2738	3250	7.5
F36	500	2287	2320	12.0
F28	500	2343	2500	16.6
F47	500	2266	3520	10.0
56	0	2210	2390	7.5
52	0	2300	3420	9.0
60	0	2470	5670	11.5
F70	0	3067	3210	20.6
F77	0	3065	2320	18.0
F68	0	3067	1900	18.6

Compression Testing

Date: 4/4/89

Sample No. 56
Storage Pressure (psi) 0

Sonic Reading 2210
E MODULUS 2391.105 (MPa)
ULT. LOAD 7.545 kPa

Cylinder Area: 0.004562 m^2

Load (kN)	Stress (kPa)	Defl'n. (in)	Strain
1.5	328.7770	0.0005	0.000125
2	438.3693	0.0007	0.000175
2.5	547.9617	0.0009	0.000225
3	657.5540	0.0011	0.000275
3.5	767.1464	0.0013	0.000325
4	876.7387	0.0015	0.000375
4.5	986.3311	0.0017	0.000425
5	1095.923	0.002	0.0005
5.5	1205.515	0.0022	0.00055
6	1315.108	0.0025	0.000625
6.5	1424.700	0.0028	0.0007
7	1534.292	0.0031	0.000775
7.5	1643.885	0.0033	0.000825
7.545	1653.748	0.0035	0.000875

3.018

Compression Testing

Date: 4/4/89

Sample No. 52
Storage Pressure (psi) 0

Sonic Reading 2300
E MODULUS 3422.099 (MPa)
ULT. LOAD 9.01 kPa

Cylinder Area: 0.004545 m^2

Load (kN)	Stress (kPa)	Defl'n. (in)	Strain
0.5	109.9960	0.00015	0.000037
1	219.9921	0.0003	0.000075
1.5	329.9882	0.0004	0.0001
2	439.9842	0.0006	0.00015
2.5	549.9803	0.0007	0.000175
3	659.9764	0.0008	0.0002
3.5	769.9724	0.0009	0.000225
4	879.9685	0.0011	0.000275
4.5	989.9646	0.0012	0.0003
5	1099.960	0.0013	0.000325
5.5	1209.956	0.0015	0.000375
6	1319.952	0.0017	0.000425
6.5	1429.948	0.0018	0.00045
7	1539.944	0.002	0.0005
7.5	1649.941	0.0023	0.000575
8	1759.937	0.0025	0.000625
8.5	1869.933	0.0027	0.000675
9	1979.929	0.0031	0.000775
9.01	1982.129	0.013	0.00325

Compression Testing

Date: 4/4/89

Sample No. 60
Storage Pressure (psi) 0

Sonic Reading 2470
E MODULUS 5672.339 (MPa)
ULT. LOAD 11.52 kPa

Cylinder Area: 0.004533 m^2

Load (kN)	Stress (kPa)	Defl'n. (in)	Strain
0.5	110.2954	0	0
1	220.5909	0	0
1.5	330.8864	0.0001	0.000025
2	441.1819	0.00015	0.000037
2.5	551.4774	0.0002	0.00005
3	661.7729	0.0003	0.000075
3.5	772.0684	0.0004	0.0001
4	882.3639	0.0006	0.00015
4.5	992.6594	0.0007	0.000175
5	1102.954	0.0008	0.0002
5.5	1213.250	0.0009	0.000225
6	1323.545	0.0011	0.000275
6.5	1433.841	0.0012	0.0003
7	1544.136	0.0013	0.000325
7.5	1654.432	0.0015	0.000375
8	1764.727	0.0016	0.0004
8.5	1875.023	0.0019	0.000475
9	1985.318	0.0021	0.000525
9.5	2095.614	0.0023	0.000575
10	2205.909	0.0024	0.0006
10.5	2316.205	0.0026	0.00065
11.52	2541.208	0.0028	0.0007

4.608

Compression Testing

Date: 4/4/89

Sample No.	45
Storage Pressure (psi)	500

Sonic Reading	2278
E MODULUS	3884.714 (MPa)
ULT. LOAD	9.6 kPa

Cylinder Area: 0.004576 m^2

Load (kN)	Stress (kPa)	Defl'n. (in)	Strain
0.5	109.2576	0.0001	0.000025
1	218.5152	0.0002	0.00005
1.5	327.7728	0.0003	0.000075
2	437.0304	0.0004	0.0001
2.5	546.2880	0.0005	0.000125
3	655.5456	0.0006	0.00015
3.5	764.8032	0.0007	0.000175
4	874.0608	0.0009	0.000225
4.5	983.3184	0.001	0.00025
5	1092.576	0.0011	0.000275
5.5	1201.833	0.0012	0.0003
6	1311.091	0.0013	0.000325
6.5	1420.348	0.0014	0.00035
7	1529.606	0.116	0.029
7.5	1638.864	0.0017	0.000425
8	1748.121	0.0019	0.000475
8.5	1857.379	0.002	0.0005
9	1966.636	0.0021	0.000525
9.5	2075.894	0.0022	0.00055
9.6	2097.745	0.0022	0.00055

Compression Testing

Date: 4/4/89

Sample No. 50
Storage Pressure (psi) 500

Sonic Reading 2738
E MODULUS 3246.464 (MPa)
ULT. LOAD 7.54 kPa

Cylinder Area: 0.004620 m^2

Load (kN)	Stress (kPa)	Defl'n. (in)	Strain
0.5	108.2154	0.0002	0.00005
1	216.4309	0.0003	0.000075
1.5	324.6464	0.0004	0.0001
2	432.8619	0.0005	0.000125
2.5	541.0774	0.0007	0.000175
3	649.2928	0.0008	0.0002
3.5	757.5083	0.001	0.00025
4	865.7238	0.0012	0.0003
4.5	973.9393	0.0014	0.00035
5	1082.154	0.0016	0.0004
5.5	1190.370	0.0018	0.00045
6	1298.585	0.0021	0.000525
6.5	1406.801	0.0025	0.000625
7	1515.016	0.0029	0.000725
7.5	1623.232	0.0031	0.000775
7.54	1631.889	0.0032	0.0008

Compression Testing

Date: 4/4/89

Sample No.	34
Storage Pressure (psi)	500

Sonic Reading	2270
E MODULUS	1748.121 (MPa)
ULT. LOAD	8.9 kPa

Cylinder Area: 0.004576 m^2

Load (kN)	Stress (kPa)	Defl'n. (in)	Strain
0.5	109.2576	0.0003	0.000075
1	218.5152	0.0005	0.000125
1.5	327.7728	0.0008	0.0002
2	437.0304	0.001	0.00025
2.5	546.2880	0.0012	0.0003
3	655.5456	0.0014	0.00035
3.5	764.8032	0.0017	0.000425
4	874.0608	0.002	0.0005
4.5	983.3184	0.0022	0.00055
5	1092.576	0.0024	0.0006
5.5	1201.833	0.0027	0.000675
6	1311.091	0.003	0.00075
6.5	1420.348	0.0033	0.000825
7	1529.606	0.0035	0.000875
7.5	1638.864	0.0038	0.00095
8	1748.121	0.0041	0.001025
8.5	1857.379	0.0042	0.00105
8.9	1944.785	0.0046	0.00115

Compression Testing

Date: 4/4/89

Sample No. 24
Storage Pressure (psi) 1000

Sonic Reading 3070
E MODULUS 3043.910 (MPa)
ULT. LOAD 10.4 (kPa)

Cylinder Area: 0.004548 m^2

Load (kN)	Stress (kPa)	Defl'n. (in)	Strain
2	439.6759	0.0005	0.000125
2.5	549.5949	0.0008	0.0002
3	659.5139	0.0009	0.000225
3.5	769.4329	0.001	0.00025
4	879.3519	0.0011	0.000275
4.5	989.2709	0.0013	0.000325
5	1099.189	0.0014	0.00035
5.5	1209.108	0.0015	0.000375
6	1319.027	0.0017	0.000425
6.5	1428.946	0.0018	0.00045
7	1538.865	0.002	0.0005
7.5	1648.784	0.0021	0.000525
8	1758.703	0.0022	0.00055
8.5	1868.622	0.0024	0.0006
9	1978.541	0.0025	0.000625
9.5	2088.460	0.0026	0.00065
10	2198.379	0.0026	0.00065
10.4	2286.315	0.0027	0.000675
4.16	914.5260		

Compression Testing

Date: 4/4/89

Sample No. 13
Storage Pressure (psi) 1000

Sonic Reading 2240
E MODULUS 2624.7 (MPa)
ULT. LOAD 11.5 (kPa)

Cylinder Area: 0.0045 m^2

Load	(Stress (kPa)	Defl'n. (in)	Strain
0.5	109.36	0.0002	0.00005
1	218.72	0.0004	0.0001
1.5	328.08	0.0005	0.000125
2	437.45	0.0006	0.00015
2.5	546.81	0.0008	0.0002
3	656.17	0.001	0.00025
3.5	765.53	0.0011	0.000275
4	874.90	0.0013	0.000325
4.5	984.26	0.0015	0.000375
5	1093.6	0.0017	0.000425
5.5	1202.9	0.0019	0.000475
6	1312.3	0.0021	0.000525
6.5	1421.7	0.0023	0.000575
7	1531.0	0.0026	0.00065
7.5	1640.4	0.0028	0.0007
8	1749.8	0.003	0.00075
8.5	1859.1	0.0033	0.000825
9	1968.5	0.0036	0.0009
9.5	2077.8	0.0039	0.000975
10	2187.2	0.0043	0.001075
10.5	2296.6	0.0045	0.001125
11	2405.9	0.0045	0.001125

4.4

Compression Testing

Date: 4/4/89

Sample No. 9
Storage Pressure (psi) 1000

Sonic Reading 2326
E MODULUS 1411.512 (MPa)
ULT. LOAD 12 kPa

Cylinder Area: 0.004554 m^2

Load (kN)	Stress (kPa)	Defl'n. (in)	Strain
1	219.5686	0.0007	0.000175
1.5	329.3529	0.001	0.00025
2	439.1372	0.0013	0.000325
2.5	548.9215	0.0017	0.000425
3	658.7059	0.0019	0.000475
3.5	768.4902	0.0022	0.00055
4	878.2745	0.0025	0.000625
4.5	988.0588	0.0028	0.0007
5	1097.843	0.003	0.00075
5.5	1207.627	0.0033	0.000825
6	1317.411	0.0036	0.0009
6.5	1427.196	0.0039	0.000975
7	1536.980	0.0042	0.00105
7.5	1646.764	0.0046	0.00115
8	1756.549	0.0049	0.001225
8.5	1866.333	0.0053	0.001325
9	1976.117	0.0057	0.001425
9.5	2085.902	0.0065	0.001625
10	2195.686	0.0095	0.002375
10.5	2305.470	0.0113	0.002825
11	2415.254	0.0121	0.003025

4.4

Compression Testing

Date: 4/4/89

Sample No. F70
Storage Pressure (psi) 0

Sonic Reading 3067
E MODULUS 3207.751 (MPa)
ULT. LOAD 20.58 kPa

Cylinder Area: 0.004534 m^2

Load (kN)	Stress (kPa)	Defl'n. (in)	Strain
0.5	110.2664	0.0002	0.00005
1	220.5329	0.0003	0.000075
1.5	330.7993	0.0004	0.0001
2	441.0658	0.0006	0.00015
2.5	551.3323	0.0007	0.000175
3	661.5987	0.0008	0.0002
3.5	771.8652	0.0009	0.000225
4	882.1316	0.001	0.00025
4.5	992.3981	0.0012	0.0003
5	1102.664	0.0013	0.000325
5.5	1212.931	0.0015	0.000375
6	1323.197	0.0016	0.0004
6.5	1433.464	0.0017	0.000425
7	1543.730	0.0019	0.000475
7.5	1653.996	0.0021	0.000525
8	1764.263	0.0022	0.00055
8.5	1874.529	0.0024	0.0006
9	1984.796	0.0025	0.000625
9.5	2095.062	0.0028	0.0007
10	2205.329	0.003	0.00075
10.5	2315.595	0.0032	0.0008
11	2425.862	0.0034	0.00085
11.5	2536.128	0.0035	0.000875
12	2646.395	0.0037	0.000925
12.5	2756.661	0.0039	0.000975
13	2866.928	0.041	0.01025
13.5	2977.194	0.0043	0.001075
14	3087.460	0.0044	0.0011
14.5	3197.727	0.0045	0.001125
15	3307.993	0.0051	0.001275
15.5	3418.260	0.0053	0.001325
16	3528.526	0.0055	0.001375
16.5	3638.793	0.0058	0.00145
17	3749.059	0.006	0.0015
17.5	3859.326	0.0062	0.00155
18	3969.592	0.0065	0.001625
18.5	4079.859	0.0067	0.001675
19	4190.125	0.007	0.00175

19.5	4300.392	0.0075	0.001875
20.58	4538.567	0.0081	0.002025

Compression Testing

Date: 4/4/89

Sample No. F77
Storage Pressure (psi) 0

Sonic Reading 3065
E MODULUS 2321.505 (MPa)
ULT. LOAD 18.05 kPa

Cylinder Area: 0.004467 m^2

Load (kN)	Stress (kPa)	Defl'n. (in)	Strain
0.5	111.9297	0.0002	0.00005
1	223.8594	0.0004	0.0001
1.5	335.7891	0.0006	0.00015
2	447.7189	0.0007	0.000175
2.5	559.6486	0.0009	0.000225
3	671.5783	0.0011	0.000275
3.5	783.5081	0.0012	0.0003
4	895.4378	0.0014	0.00035
4.5	1007.367	0.0017	0.000425
5	1119.297	0.0018	0.00045
5.5	1231.227	0.0021	0.000525
6	1343.156	0.0022	0.00055
6.5	1455.086	0.0025	0.000625
7	1567.016	0.0027	0.000675
7.5	1678.945	0.003	0.00075
8	1790.875	0.0033	0.000825
8.5	1902.805	0.0036	0.0009
9	2014.735	0.0039	0.000975
9.5	2126.664	0.0042	0.00105
10	2238.594	0.0045	0.001125
10.5	2350.524	0.0049	0.001225
11	2462.454	0.0052	0.0013
11.5	2574.383	0.0056	0.0014
12	2686.313	0.0059	0.001475
12.5	2798.243	0.0063	0.001575
13	2910.172	0.0068	0.0017
13.5	3022.102	0.0073	0.001825
14	3134.032	0.0078	0.00195
14.5	3245.962	0.0083	0.002075
15	3357.891	0.0089	0.002225
15.5	3469.821	0.0095	0.002375
16	3581.751	0.0102	0.00255
16.5	3693.681	0.0109	0.002725
17	3805.610	0.0016	0.0004
17.5	3917.540	0.0124	0.0031
18	4029.470	0.0137	0.003425
18.05	4040.663	0.0147	0.003675

Compression Testing

Date: 4/4/89

Sample No. F68
Storage Pressure (psi) 0

Sonic Reading 3067
E MODULUS 1901.778 (MPa)
ULT. LOAD 18.55 kPa

Cylinder Area: 0.004507 m^2

Load (kN)	Stress (kPa)	Defl'n. (in)	Strain
0.5	110.9370	0.0003	0.000075
1	221.8741	0.0005	0.000125
1.5	332.8111	0.0007	0.000175
2	443.7482	0.0009	0.000225
2.5	554.6852	0.0011	0.000275
3	665.6223	0.0014	0.00035
3.5	776.5593	0.0016	0.0004
4	887.4964	0.0018	0.00045
4.5	998.4334	0.002	0.0005
5	1109.370	0.0022	0.00055
5.5	1220.307	0.0025	0.000625
6	1331.244	0.0027	0.000675
6.5	1442.181	0.0029	0.000725
7	1553.118	0.0032	0.0008
7.5	1664.055	0.0035	0.000875
8	1774.992	0.0038	0.00095
8.5	1885.929	0.0041	0.001025
9	1996.866	0.0044	0.0011
9.5	2107.804	0.0047	0.001175
10	2218.741	0.0051	0.001275
10.5	2329.678	0.0054	0.00135
11	2440.615	0.0058	0.00145
11.5	2551.552	0.0062	0.00155
12	2662.489	0.0066	0.00165
12.5	2773.426	0.007	0.00175
13	2884.363	0.0075	0.001875
13.5	2995.300	0.008	0.002
14	3106.237	0.0085	0.002125
14.5	3217.174	0.009	0.00225
15	3328.111	0.0097	0.002425
15.5	3439.048	0.0104	0.0026
16	3549.985	0.011	0.00275
16.5	3660.922	0.0117	0.002925
17	3771.859	0.0124	0.0031
17.5	3882.796	0.0132	0.0033
18	3993.733	0.0142	0.00355
18.5	4104.670	0.0152	0.0038
18.5	4104.670	0.0158	0.00395

Compression Testing

Date: 4/4/89

Sample No. F36
Storage Pressure (psi) 500

Sonic Reading 2287
E MODULUS 2322.010 (MPa)
ULT. LOAD 12 kPa

Cylinder Area: 0.004533 m^2

Load (kN)	Stress (kPa)	Defl'n. (in)	Strain
0.5	110.2954	0.0003	0.000075
1	220.5909	0.0004	0.0001
1.5	330.8864	0.0006	0.00015
2	441.1819	0.0008	0.0002
2.5	551.4774	0.0009	0.000225
3	661.7729	0.0011	0.000275
3.5	772.0684	0.0013	0.000325
4	882.3639	0.0015	0.000375
4.5	992.6594	0.0017	0.000425
5	1102.954	0.0019	0.000475
5.5	1213.250	0.0021	0.000525
6	1323.545	0.0022	0.00055
6.5	1433.841	0.0025	0.000625
7	1544.136	0.0026	0.00065
7.5	1654.432	0.0029	0.000725
8	1764.727	0.0031	0.000775
8.5	1875.023	0.0033	0.000825
9	1985.318	0.0035	0.000875
9.5	2095.614	0.0038	0.00095
10	2205.909	0.004	0.001
10.5	2316.205	0.0042	0.00105
11	2426.500	0.0045	0.001125
11.5	2536.796	0.0048	0.0012
12	2647.091	0.0051	0.001275

4.8

Compression Testing

Date: 4/4/89

Sample No. F28
Storage Pressure (psi) 500

Sonic Reading 2343
E MODULUS 2499.336 (MPa)
ULT. LOAD 16.55 kPa

Cylinder Area: 0.004522 m^2

Load (kN)	Stress (kPa)	Defl'n. (in)	Strain
0.5	110.5475	0.0003	0.000075
1	221.0951	0.0005	0.000125
1.5	331.6426	0.0006	0.00015
2	442.1902	0.007	0.00175
2.5	552.7378	0.0009	0.000225
3	663.2853	0.001	0.00025
3.5	773.8329	0.0012	0.0003
4	884.3804	0.0014	0.00035
4.5	994.9280	0.0016	0.0004
5	1105.475	0.0017	0.000425
5.5	1216.023	0.0019	0.000475
6	1326.570	0.0021	0.000525
6.5	1437.118	0.0023	0.000575
7	1547.665	0.0025	0.000625
7.5	1658.213	0.0028	0.0007
8	1768.760	0.003	0.00075
8.5	1879.308	0.0032	0.0008
9	1989.856	0.0034	0.00085
9.5	2100.403	0.0037	0.000925
10	2210.951	0.0039	0.000975
10.5	2321.498	0.0041	0.001025
11	2432.046	0.0044	0.0011
11.5	2542.593	0.0047	0.001175
12	2653.141	0.0049	0.001225
12.5	2763.689	0.0053	0.001325
13	2874.236	0.0055	0.001375
13.5	2984.784	0.0061	0.001525
14	3095.331	0.0064	0.0016
14.5	3205.879	0.0066	0.00165
15	3316.426	0.007	0.00175
15.5	3426.974	0.0074	0.00185
16	3537.521	0.0078	0.00195
16.55	3659.124	0.008	0.002

Compression Testing

Date: 4/4/89

Sample No. F47
Storage Pressure (psi) 500

Sonic Reading 2266
E MODULUS 3515.867 (MPa)
ULT. LOAD 10 kPa

Cylinder Area: 0.004550 m^2

Load (kN)	Stress (kPa)	Defl'n. (in)	Strain
0.5	109.8708	0.0002	0.00005
1	219.7417	0.0003	0.000075
1.5	329.6126	0.0004	0.0001
2	439.4834	0.0005	0.000125
2.5	549.3543	0.0006	0.00015
3	659.2252	0.0008	0.0002
3.5	769.0960	0.0009	0.000225
4	878.9669	0.001	0.00025
4.5	988.8378	0.0012	0.0003
5	1098.708	0.0013	0.000325
5.5	1208.579	0.0014	0.00035
6	1318.450	0.0016	0.0004
6.5	1428.321	0.0017	0.000425
7	1538.192	0.0018	0.00045
7.5	1648.063	0.002	0.0005
8	1757.933	0.0021	0.000525
8.5	1867.804	0.0022	0.00055
9	1977.675	0.0024	0.0006
9.5	2087.546	0.0026	0.00065
10	2197.417	0.0027	0.000675

Compression Testing

Date: 4/4/89

Sample No. F13
Storage Pressure (psi) 1000

Sonic Reading 2397
E MODULUS 1392.185 (MPa)
ULT. LOAD 12.59 kPa

Cylinder Area: 0.004514 m^2

Load (kN)	Stress (kPa)	Defl'n. (in)	Strain
0.5	110.7420	0.0006	0.00015
1	221.4841	0.0009	0.000225
1.5	332.2261	0.0011	0.000275
2	442.9682	0.0014	0.00035
2.5	553.7102	0.0017	0.000425
3	664.4523	0.002	0.0005
3.5	775.1943	0.0023	0.000575
4	885.9364	0.0026	0.00065
4.5	996.6784	0.00029	0.000072
5	1107.420	0.0033	0.000825
5.5	1218.162	0.0035	0.000875
6	1328.904	0.0038	0.00095
6.5	1439.646	0.0042	0.00105
7	1550.388	0.0045	0.001125
7.5	1661.130	0.0048	0.0012
8	1771.872	0.0052	0.0013
8.5	1882.614	0.0056	0.0014
9	1993.356	0.0059	0.001475
9.5	2104.098	0.0063	0.001575
10	2214.841	0.0067	0.001675
10.5	2325.583	0.0071	0.001775
11	2436.325	0.0075	0.001875
11.5	2547.067	0.0079	0.001975
12	2657.809	0.0084	0.0021
12.5	2768.551	0.0088	0.0022
13	2879.293	0.0093	0.002325
13.5	2990.035	0.0096	0.0024

Compression Testing

Date: 4/4/89

Sample No. F5
Storage Pressure (psi) 1000

Sonic Reading 2730
E MODULUS 2203.975 (MPa)
ULT. LOAD 14.99 kPa

Cylinder Area: 0.004537 m^2

Load (kN)	Stress (kPa)	Defl'n. (in)	Strain
0.5	110.1987	0.0002	0.00005
1	220.3975	0.0003	0.000075
1.5	330.5963	0.0005	0.000125
2	440.7950	0.0007	0.000175
2.5	550.9938	0.0009	0.000225
3	661.1926	0.0011	0.000275
3.5	771.3913	0.0013	0.000325
4	881.5901	0.0015	0.000375
4.5	991.7889	0.0017	0.000425
5	1101.987	0.002	0.0005
5.5	1212.186	0.0033	0.000825
6	1322.385	0.0024	0.0006
6.5	1432.584	0.0026	0.00065
7	1542.782	0.0028	0.0007
7.5	1652.981	0.0031	0.000775
8	1763.180	0.0033	0.000825
8.5	1873.379	0.0036	0.0009
9	1983.577	0.0038	0.00095
9.5	2093.776	0.0041	0.001025
10	2203.975	0.0043	0.001075
10.5	2314.174	0.0045	0.001125
11	2424.372	0.0049	0.001225
11.5	2534.571	0.0051	0.001275
12	2644.770	0.0054	0.00135
12.5	2754.969	0.0057	0.001425
13	2865.168	0.0061	0.001525
13.5	2975.366	0.0065	0.001625
14	3085.565	0.0068	0.0017
14.5	3195.764	0.0077	0.001925
14.99	3303.759	0.01	0.0025

Compression Testing

Date: 4/4/89

Sample No. F18
Storage Pressure (psi) 1000

Sonic Reading 2180
E MODULUS 2206.684 (MPa)
ULT. LOAD 16.9 kPa

Cylinder Area: 0.004531 m^2

Load (kN)	Stress (kPa)	Defl'n. (in)	Strain
0.5	110.3342	0.0003	0.000075
1	220.6684	0.0005	0.000125
1.5	331.0026	0.0007	0.000175
2	441.3368	0.0008	0.0002
2.5	551.6710	0.001	0.00025
3	662.0052	0.0012	0.0003
3.5	772.3395	0.0014	0.00035
4	882.6737	0.0016	0.0004
4.5	993.0079	0.0018	0.00045
5	1103.342	0.002	0.0005
5.5	1213.676	0.0022	0.00055
6	1324.010	0.0024	0.0006
6.5	1434.344	0.0026	0.00065
7	1544.679	0.0028	0.0007
7.5	1655.013	0.003	0.00075
8	1765.347	0.0032	0.0008
8.5	1875.681	0.0034	0.00085
9	1986.015	0.0037	0.000925
9.5	2096.350	0.0039	0.000975
10	2206.684	0.0041	0.001025
10.5	2317.018	0.0043	0.001075
11	2427.352	0.0046	0.00115
11.5	2537.686	0.0048	0.0012
12	2648.021	0.005	0.00125
12.5	2758.355	0.0053	0.001325
13	2868.689	0.0055	0.001375
13.5	2979.023	0.0059	0.001475
14	3089.358	0.0061	0.001525
14.5	3199.692	0.0065	0.001625
15	3310.026	0.0068	0.0017
15.5	3420.360	0.0072	0.0018
16	3530.694	0.0075	0.001875
16.5	3641.029	0.0079	0.001975
16.9	3729.296	0.0088	0.0022

6.76

Cylinder Splitting

November 30, 1989

Storage Pressure (psi)	Sample Number		Splitting Load (KN)
1000	F3		12.54
	F9		10.94
	F15		10.1
	F18		9.56
		12	7.47
		16	5.2
		18	17.35
		21	5.78
		25	10.63
500	F32		13.12
	F34		14.46
	F35		12.79
		27	10.59
		28	13.12
		30	10.56
		36	14.9
		41	14.9
		47	18.79
0	F54		20.68
	F55		27.18
	F63		24.91
	F66		26.07

Compression Testing

Date: 30/11/89

Sample No. F4
Storage Pressure (psi) 1000

Sonic Reading 2231
E MODULUS 2083.9 (MPa)
ULT. LOAD 14.2 KN

Cylinder Area: 0.004527 m^2

Load (lb)	Load (KN)	Stress (kPa)	Defl'n. (in)	Strain
400	1.8	392.96	0.0001	0.000016
800	3.6	785.92	0.0002	0.000033
1100	4.9	1080.63	0.0003	0.000049
1400	6.2	1375.35	0.0004	0.000066
1600	7.1	1571.83	0.0005	0.000083
1700	7.6	1670.07	0.0006	0.000099
1700	7.6	1670.07	0.0007	0.000116
1800	8.0	1768.31	0.0008	0.000133
1800	8.0	1768.31	0.0009	0.000149
1900	8.5	1866.55	0.001	0.000166
2000	8.9	1964.79	0.0011	0.000182
2000	8.9	1964.79	0.0012	0.000199
2000	8.9	1964.79	0.0013	0.000216
2000	8.9	1964.79	0.0014	0.000232
2000	8.9	1964.79	0.0015	0.000249
2000	8.9	1964.79	0.0016	0.000266
2000	8.9	1964.79	0.0017	0.000282
2000	8.9	1964.79	0.0018	0.000299
2000	8.9	1964.79	0.0019	0.000316
2100	9.3	2063.03	0.002	0.000332
2200	9.8	2161.27	0.0024	0.000399
2500	11.1	2455.99	0.0029	0.000482
2600	11.6	2554.23	0.0036	0.000598
2900	12.9	2848.95	0.0045	0.000748
3000	13.3	2947.19	0.0055	0.000914
3200	14.2	3143.66	0.0067	0.001114

Compression Testing

Date: [illegible]

Sample No. F10
Storage Pressure (psi) 1000

Sonic Reading 2590
E MODULUS 2369.3 (MPa)
ULT. LOAD 20.9 KN

Cylinder Area: 0.004523 m^2

Load (lb)	Load (KN)	Stress (kPa)	Defl'n. (in)	Strain
500	2.2	491.63	0.0001	0.000016
900	4.0	884.93	0.0002	0.000033
1300	5.8	1278.24	0.0003	0.000049
1600	7.1	1573.21	0.0004	0.000066
2000	8.9	1966.52	0.0005	0.000083
2300	10.2	2261.49	0.0006	0.000099
2500	11.1	2458.15	0.0007	0.000116
2700	12.0	2654.80	0.0008	0.000133
3000	13.3	2949.78	0.0009	0.000149
3800	16.9	3736.38	0.001	0.000166
4100	18.2	4031.36	0.0011	0.000182
4400	19.6	4326.34	0.0012	0.000199
4700	20.9	4621.31	0.0013	0.000216

Compression Testing

Date: 30/11/89

Sample No. F19
Storage Pressure (psi) 1000

Sonic Reading 2729
E MODULUS 2612.3 (MPa)
ULT. LOAD 15.6 KN

Cylinder Area: 0.004517 m^2

Load (lb)	Load (KN)	Stress (kPa)	Defl'n. (in)	Strain
500	2.2	492.32	0.0001	0.000016
900	4.0	886.18	0.0002	0.000033
1300	5.8	1280.03	0.0003	0.000049
1600	7.1	1575.43	0.0004	0.000066
1800	8.0	1772.36	0.0005	0.000083
2000	8.9	1969.28	0.0006	0.000099
2100	9.3	2067.75	0.0007	0.000116
2200	9.8	2166.21	0.0008	0.000133
2300	10.2	2264.68	0.0009	0.000149
2600	11.6	2560.07	0.001	0.000166
3200	14.2	3150.85	0.0011	0.000182
3500	15.6	3446.25	0.0012	0.000199
[illegible]	15.6	3446.25	0.0013	0.000216

Compression Testing

Date: 30/11/89

Sample No. F20
Storage Pressure (psi) 1000

Sonic Reading 3151
E MODULUS 2370.1 (MPa)
ULT. LOAD 20.5 KN

Cylinder Area: 0.004522 m^2

Load (lb)	Load (KN)	Stress (kPa)	Defl'n. (in)	Strain
900	4.0	885.24	0.0001	0.000016
1300	5.8	1278.69	0.0002	0.000033
1500	6.7	1475.41	0.0003	0.000049
1600	7.1	1573.77	0.0004	0.000066
2000	8.9	1967.21	0.0005	0.000083
2500	11.1	2459.01	0.0006	0.000099
2700	12.0	2655.73	0.0007	0.000116
3100	13.8	3049.17	0.0008	0.000133
3400	15.1	3344.25	0.0009	0.000149
3800	16.9	3737.69	0.001	0.000166
4100	18.2	4032.78	0.0011	0.000182
4300	19.1	4229.50	0.0012	0.000199
4500	20.0	4426.22	0.0013	0.000216
4600	20.5	4524.58	0.0014	0.000232
4600	20.5	4524.58	0.0015	0.000249

Compression Testing

Date: 30/11/89

Sample No. F22
Storage Pressure (psi) 1000

Sonic Reading 3962
E MODULUS 2072 (MPa)
ULT. LOAD 8.9 KN

Cylinder Area: 0.004553 m^2

Load (lb)	Load (KN)	Stress (kPa)	Defl'n. (in)	Strain
400	1.8	390.72	0.0001	0.000016
700	3.1	683.77	0.0002	0.000033
1000	4.4	976.81	0.0003	0.000049
1300	5.8	1269.86	0.0004	0.000066
1500	6.7	1465.22	0.0005	0.000083
1700	7.6	1660.58	0.0006	0.000099
1800	8.0	1758.26	0.0007	0.000116
1800	8.0	1758.26	0.0008	0.000133
1900	8.5	1855.94	0.0009	0.000149
2000	8.9	1953.62	0.001	0.000166
2000	8.9	1953.62	0.0011	0.000182
2000	8.9	1953.62	0.0012	0.000199

Compression Testing

Date: 30/11/89

Sample No. 1
Storage Pressure (psi) 1000

Sonic Reading 4082
E MODULUS 2767.8 (MPa)
ULT. LOAD 19.6 KN

Cylinder Area: 0.004626 m^2

Load (lb)	Load (KN)	Stress (kPa)	Defl'n. (in)	Strain
600	2.7	576.86	0.0001	0.000016
1100	4.9	1057.57	0.0002	0.000033
1500	6.7	1442.15	0.0003	0.000049
1900	8.5	1826.72	0.0004	0.000066
2100	9.3	2019.01	0.0005	0.000083
2500	11.1	2403.58	0.0006	0.000099
2800	12.5	2692.01	0.0007	0.000116
3100	13.8	2980.44	0.0008	0.000133
3300	14.7	3172.72	0.0009	0.000149
3600	16.0	3461.15	0.001	0.000166
3800	16.9	3653.44	0.0011	0.000182
3900	17.3	3749.58	0.0012	0.000199
4100	18.2	3941.87	0.0013	0.000216
4300	19.1	4134.15	0.0014	0.000232
4400	19.6	4230.30	0.0015	0.000249
4400	19.6	4230.30	0.0016	0.000266

Compression Testing

Date: 30/11/89

Sample No. 2
Storage Pressure (psi) 1000

Sonic Reading 4067
E MODULUS 2917.7 (MPa)
ULT. LOAD 21.4 KN

Cylinder Area: 0.004619 m^2

Load (lb)	Load (KN)	Stress (kPa)	Defl'n. (in)	Strain
700	3.1	674.00	0.0001	0.000016
1100	4.9	1059.14	0.0002	0.000033
1600	7.1	[illegible]	0.0003	0.000049
2000	8.9	1925.70	0.0004	0.000066
2500	11.1	2407.13	0.0005	0.000083
3000	13.3	2888.56	0.0006	0.000099
3300	14.7	3177.41	0.0007	0.000116
3700	16.5	3562.55	0.0008	0.000133
3900	17.3	3755.12	0.0009	0.000149
4200	18.7	4043.98	0.001	0.000166
4400	19.6	4236.55	0.0011	0.000182
4500	20.0	4332.84	0.0012	0.000199
4700	20.9	4525.41	0.0013	0.000216
4800	21.4	4621.69	0.0014	0.000232

Compression Testing

Date: 30/11/89

Sample No.	3
Storage Pressure (psi)	1000

Sonic Reading	4050
E MODULUS	3068.4 (MPa)
ULT. LOAD	19.6 KN

Cylinder Area: 0.004612 m^2

Load (lb)	Load (KN)	Stress (kPa)	Defl'n. (in)	Strain
600	2.7	578.62	0.0001	0.000016
1000	4.4	964.36	0.0002	0.000033
1500	6.7	1446.54	0.0003	0.000049
2100	9.3	2025.16	0.0004	0.000066
2500	11.1	2410.90	0.0005	0.000083
3200	14.2	3085.95	0.0006	0.000099
2800	12.5	2700.21	0.0007	0.000116
3100	13.8	2989.52	0.0008	0.000133
3500	15.6	3375.26	0.0009	0.000149
3700	16.5	3568.13	0.001	0.000166
3900	17.3	3761.01	0.0011	0.000182
4300	19.1	4146.75	0.0012	0.000199
4400	19.6	4243.19	0.0013	0.000216

Compression Testing

Date: 30/11/89

Sample No.	8
Storage Pressure (psi)	1000

Sonic Reading	3945	
E MODULUS	2204	(MPa)
ULT. LOAD	18.2	KN

Cylinder Area: 0.004586 m^2

Load (lb)	Load (KN)	Stress (kPa)	Defl'n. (in)	Strain
500	2.2	484.88	0.0001	0.000016
800	3.6	775.80	0.0002	0.000033
1200	5.3	1163.70	0.0003	0.000049
1500	6.7	1454.63	0.0004	0.000066
1900	8.5	1842.53	0.0005	0.000083
2200	9.8	2133.46	0.0006	0.000099
2500	11.1	2424.38	0.0007	0.000116
2700	12.0	2618.33	0.0008	0.000133
2900	12.9	2812.28	0.0009	0.000149
3600	16.0	3491.11	0.001	0.000166
4100	18.2	3975.98	0.0011	0.000182

Compression Testing

Date: 30/11/89

Sample No. 11
Storage Pressure (psi) 1000

Sonic Reading 4067
E MODULUS 2625.7 (MPa)
ULT. LOAD 20 KN

Cylinder Area: 0.004620 m^2

Load (lb)	Load (KN)	Stress (kPa)	Defl'n. (in)	Strain
1000	4.4	962.77	0.0002	0.000033
1400	6.2	1347.88	0.0003	0.000049
1800	8.0	1732.98	0.0004	0.000066
2100	9.3	2021.81	0.0005	0.000083
2500	11.1	2406.92	0.0006	0.000099
2900	12.9	2792.03	0.0007	0.000116
3300	14.7	3177.14	0.0008	0.000133
3600	16.0	3465.97	0.0009	0.000149
4400	19.6	4236.18	0.001	0.000166
4000	17.8	3851.07	0.0011	0.000182
4200	18.7	4043.63	0.0012	0.000199
4500	20.0	4332.46	0.0013	0.000216

Compression Testing

Date: 30/11/89

Sample No. F29
Storage Pressure (psi) 500

Sonic Reading 2252
E MODULUS 3221.4 (MPa)
ULT. LOAD 20 KN

Cylinder Area: 0.004534 m^2

Load (lb)	Load (KN)	Stress (kPa)	Defl'n. (in)	Strain
500	2.2	490.51	0.0001	0.000016
1000	4.4	981.02	0.0002	0.000033
2100	9.3	2060.13	0.0004	0.000066
2500	11.1	2452.54	0.0005	0.000083
3000	13.3	2943.05	0.0006	0.000099
4000	17.8	3924.07	0.0007	0.000116
4000	17.8	3924.07	0.0008	0.000133
4000	17.8	3924.07	0.0009	0.000149
4000	17.8	3924.07	0.001	0.000166
4000	17.8	3924.07	0.0011	0.000182
4200	18.7	4120.27	0.0012	0.000199
4500	20.0	4414.57	0.0013	0.000216

Compression Testing

Date: 30/11/89

Sample No. F33
Storage Pressure (psi) 500

Sonic Reading 2224
E MODULUS 2967.4 (MPa)
ULT. LOAD 20 KN

Cylinder Area: 0.004528 m^2

Load (lb)	Load (KN)	Stress (kPa)	Defl'n. (in)	Strain
600	2.7	589.33	0.0001	0.000016
1000	4.4	982.22	0.0002	0.000033
1500	6.7	1473.33	0.003	0.000498
2000	8.9	1964.45	0.0004	0.000066
2600	11.6	2553.78	0.0005	0.000083
2800	12.5	2750.22	0.0006	0.000099
2900	12.9	2848.45	0.0007	0.000116
3000	13.3	2946.67	0.0008	0.000133
4200	18.7	4125.34	0.0009	0.000149
4200	18.7	4125.34	0.001	0.000166
4400	19.6	4321.78	0.0011	0.000182
4500	20.0	4420.00	0.0012	0.000199

Compression Testing

Date: 30/11/89

Sample No. F41
Storage Pressure (psi) 500

Sonic Reading 2537
E MODULUS 3355.3 (MPa)
ULT. LOAD 20 KN

Cylinder Area: 0.004525 m^2

Load (lb)	Load (KN)	Stress (kPa)	Defl'n. (in)	Strain
600	2.7	589.75	0.0001	0.000016
1200	5.3	1179.50	0.0002	0.000033
1700	7.6	1670.95	0.003	0.000498
2100	9.3	2064.12	0.0004	0.000066
2400	10.7	2358.99	0.0005	0.000083
2800	12.5	2752.16	0.0006	0.000099
3100	13.8	3047.03	0.0007	0.000116
3700	16.5	3636.78	0.0008	0.000133
4000	17.8	3931.65	0.0009	0.000149
4200	18.7	4128.23	0.001	0.000166
4400	19.6	4324.82	0.0011	0.000182
4500	20.0	4423.11	0.0012	0.000199

Compression Testing

Date: 30/11/89

Sample No. 32
Storage Pressure (psi) 500

Sonic Reading 4022
E MODULUS 2478.3 (MPa)
ULT. LOAD 19.1 KN

Cylinder Area: 0.004622 m^2

Load (lb)	Load (KN)	Stress (kPa)	Defl'n. (in)	Strain
500	2.2	481.09	0.0001	0.000016
900	4.0	865.96	0.0002	0.000033
1300	5.8	1250.84	0.0003	0.000049
1700	7.6	1635.71	0.0004	0.000066
2100	9.3	2020.58	0.0005	0.000083
2500	11.1	2405.46	0.0006	0.000099
2900	12.9	2790.33	0.0007	0.000116
3300	14.7	3175.20	0.0008	0.000133
3700	16.5	3560.08	0.0009	0.000149
4000	17.8	3848.73	0.001	0.000166
4300	19.1	4137.39	0.0011	0.000182
4300	19.1	4137.39	0.00114	0.000189

Compression Testing

Date: 30/11/89

Sample No. 33
Storage Pressure (psi) 500

Sonic Reading 4271
E MODULUS 2218.2 (MPa)
ULT. LOAD 21.8 KN

Cylinder Area: 0.004590 m^2

Load (lb)	Load (KN)	Stress (kPa)	Defl'n. (i	Strain
600	2.7	581.39	0.0001	0.000016
900	4.0	872.09	0.0002	0.000033
1300	5.8	1259.69	0.0003	0.000049
1600	7.1	1550.39	0.0004	0.000066
1900	8.5	1841.08	0.0005	0.000083
2200	9.8	2131.78	0.0006	0.000099
2500	11.1	2422.48	0.0007	0.000116
2800	12.5	2713.18	0.0008	0.000133
3100	13.8	3003.87	0.0009	0.000149
3400	15.1	3294.57	0.001	0.000166
3700	16.5	3585.27	0.0011	0.000182
3900	17.3	3779.07	0.0012	0.000199
4100	18.2	3972.86	0.0013	0.000216
4300	19.1	4166.66	0.0014	0.000232
4300	19.1	4166.66	0.0015	0.000249
4300	19.1	4166.66	0.0016	0.000266
4900	21.8	4748.06	0.002	0.000332

Compression Testing

Date: 30/11/89

Sample No. 36
Storage Pressure (psi) 500

Sonic Reading 4259
E MODULUS 3529.3 (MPa)
ULT. LOAD 21.4 KN

Cylinder Area: 0.004629 m^2

Load (lb)	Load (KN)	Stress (kPa)	Defl'n. (in)	Strain
700	3.1	672.53	0.0001	0.000016
1300	5.8	1248.99	0.0002	0.000033
1800	8.0	1729.37	0.0003	0.000049
2300	10.2	2209.76	0.0004	0.000066
2900	12.9	2786.21	0.0005	0.000083
3200	14.2	3074.44	0.0006	0.000099
3600	16.0	3458.75	0.0007	0.000116
4000	17.8	3843.05	0.0008	0.000133
4800	21.4	4611.66	0.0009	0.000149

Compression Testing

Date: 30/11/89

Sample No. 42
Storage Pressure (psi) 500

Sonic Reading 4121
E MODULUS 2910.1 (MPa)
ULT LOAD 21.8 KN

Cylinder Area: 0.004631 m^2

Load (lb)	Load (KN)	Stress (kPa)	Defl'n. (in)	Strain
600	2.7	576.21	0.0001	0.000016
1100	4.9	1056.38	0.0002	0.000033
1500	6.7	1440.52	0.0003	0.000049
2000	8.9	1920.69	0.0004	0.000066
2300	10.2	2208.80	0.0005	0.000083
2600	11.6	2496.90	0.0006	0.000099
3000	13.3	2881.04	0.0007	0.000116
3300	14.7	3169.14	0.0008	0.000133
3600	16.0	3457.25	0.0009	0.000149
3900	17.3	3745.35	0.001	0.000166
4100	18.2	3937.42	0.0011	0.000182
4400	19.6	4225.52	0.0012	0.000199
4500	20.0	4321.56	0.0013	0.000216
4900	21.8	4705.70	0.0014	0.000232

Compression Testing

Date: 30/11/89

Sample No. 51
Storage Pressure (psi) 500

Sonic Reading 4029
E MODULUS 2572.2 (MPa)
ULT. LOAD 17.3 KN

Cylinder Area: 0.004619 m^2

Load (lb)	Load (KN)	Stress (kPa)	Defl'n. (in)	Strain
700	3.1	674.06	0.0001	0.000016
1200	5.3	1155.52	0.0002	0.000033
1900	8.5	1829.58	0.0003	0.000049
2300	10.2	2214.75	0.0004	0.000066
2700	12.0	2599.93	0.0005	0.000083
3000	13.3	2888.81	0.0006	0.000099
3400	15.1	3273.98	0.0007	0.000116
3600	16.0	3466.57	0.0008	0.000133
3900	17.3	3755.45	0.00088	0.000146

Compression Testing

Date: 30/11/89

Sample No. F56
Storage Pressure (psi) 0

Sonic Reading 4002
E MODULUS 4480 (MPa)
ULT. LOAD 35.6 KN

Cylinder Area: 0.004513 m^2

Load (lb)	Load (KN)	Stress (kPa)	Defl'n. (in)	Strain
3000	13.3	2956.78	0.0004	0.000066
3500	15.6	3449.58	0.0005	0.000083
4300	19.1	4238.06	0.0006	0.000099
5000	22.2	4927.97	0.0007	0.000116
5700	25.4	5617.89	0.0008	0.000133
6300	28.0	6209.25	0.0009	0.000149
6700	29.8	6603.48	0.001	0.000166
7000	31.1	6899.16	0.0011	0.000182
7900	35.1	7786.20	0.0012	0.000199
8000	35.6	7884.76	0.0013	0.000216

Compression Testing

Date: 30/11/89

Sample No. F61
Storage Pressure (psi) 0

Sonic Reading 2852
E MODULUS 3285.6 (MPa)
ULT. LOAD 26.7 KN

Cylinder Area: 0.004512 m^2

Load (lb)	Load (KN)	Stress (kPa)	Defl'n. (in)	Strain
600	2.7	591.41	0.0001	0.000016
1300	5.8	1281.39	0.0002	0.000033
1800	8.0	1774.23	0.0003	0.000049
2200	9.8	2168.50	0.0004	0.000066
2700	12.0	2661.34	0.0005	0.000083
3100	13.8	3055.61	0.0006	0.000099
3600	16.0	3548.45	0.0007	0.000116
4000	17.8	3942.72	0.0008	0.000133
4200	18.7	4139.86	0.0009	0.000149
4600	20.5	4534.13	0.001	0.000166
4800	21.4	4731.27	0.0011	0.000182
5300	23.6	5224.11	0.0012	0.000199
5600	24.9	5519.81	0.0013	0.000216
6000	26.7	5914.09	0.0014	0.000232
6000	26.7	5914.09	0.0015	0.000249

Compression Testing

Date: 30/11/89

Sample No. F73
Storage Pressure (psi) 0

Sonic Reading 4015
E MODULUS 10402.1 (MPa)
ULT. LOAD 28.5 KN

Cylinder Area: 0.004501 m^2

Load (lb)	Load (KN)	Stress (kPa)	Defl'n. (in)	Strain
1000	4.4	988.20	0.00006	0.000009
2000	8.9	1976.40	0.00012	0.000019
3000	13.3	2964.60	0.00038	0.000063
4000	17.8	3952.80	0.00052	0.000086
5000	22.2	4941.00	0.00067	0.000111
6000	26.7	5929.20	0.00082	0.000136
6400	28.5	6324.48	0.00089	0.000148

Compression Testing

Date: 30/11/89

Sample No. F79
Storage Pressure (psi) 0

Sonic Reading 2917
E MODULUS 2477.3 (MPa)
ULT. LOAD 24 KN

Cylinder Area: 0.004542 m^2

Load (lb)	Load (KN)	Stress (kPa)	Defl'n. (in)	Strain
1000	4.4	979.13	0.0002	0.000033
1400	6.2	1370.78	0.0003	0.000049
1700	7.6	1664.51	0.0004	0.000066
2100	9.3	2056.16	0.0005	0.000083
2500	11.1	2447.81	0.0006	0.000099
2800	12.5	2741.55	0.0007	0.000116
3100	13.8	3035.29	0.0008	0.000133
3400	15.1	3329.03	0.0009	0.000149
3700	16.5	3622.76	0.001	0.000166
4000	17.8	3916.50	0.0011	0.000182
4100	18.2	4014.41	0.0012	0.000199
4400	19.6	4308.15	0.0013	0.000216
4600	20.5	4503.98	0.0014	0.000232
5200	23.1	5091.45	0.0015	0.000249
5400	24.0	5287.28	0.00154	0.000256

ENVIRONMENTAL ENGINEERING LABORATORY

UNIVERSITY OF SASKATCHEWAN

DEPARTMENT OF CIVIL ENGINEERING

TO: Dr. M. Haug REPORTING DATE: Jan. 25, 1990

SOURCE: CCP Brine, collected Nov. 30, 1989 COLLECTION DATE: Nov. 30, 1989

LAB NO: 1130-89L ANALYSIS DATE: Jan. 22, 1990

APPEARANCE: clear,colorless
ODOR: H2S
pH= 6.3

TOTAL DISSOLVED SOLIDS	mg/l	umhos/cm
By evaporation at 103°C	335,400	
By conductivity at 25°C	437,680	604,000

CATIONS	mg/l	ANIONS	mg/l
Total Hardness*	43,961	P. Alkalinity*	0
Calcium Hardness*	23,978	Carbonate as CO3	0
Magnesium Hardness*	19,982	Total Alkalinity*	14
Sodium as Na	93,916	Bicarbonate as HCO3	17
Potassium as K	4,596	Chloride as Cl	179,521
Iron as Fe	0.00	Nitrate as NO3	0.00
Manganese as Mn	0.00	Fluoride as F	0.00
*=as CaCO3		Sulfate as SO4	247

NOTE: .00 for Fe=<0.05; .00 for Mn=<0.03; .00 for NO3=<0.2

REPORTED BY: _____

C. D. FISHER

ENVIRONMENTAL ENGINEERING LABORATORY

UNIVERSITY OF SASKATCHEWAN

DEPARTMENT OF CIVIL ENGINEERING

TO: Dr. M. D. Haug REPORTING DATE: April 18, 1989

SOURCE: Brine, picked up Dec. 27, 1989 COLLECTION DATE: March 29, 1989

LAB NO: 0329-891 ANALYSIS DATE: April 7, 1989

APPEARANCE: clear,colorless
ODOR: H2S
pH= 6.8

TOTAL DISSOLVED SOLIDS	mg/l	umhos/cm
By evaporation at 103°C	339,200	
By conductivity at 25°C	426,160	584,000

CATIONS	mg/l	ANIONS	mg/l
Total Hardness*	39,375	P. Alkalinity*	0
Calcium Hardness*	32,308	Carbonate as CO3	0
Magnesium Hardness*	7,067	Total Alkalinity*	21
Sodium as Na	96,923	Bicarbonate as HCO3	25
Potassium as K	3,392	Chloride as Cl	179,989
Iron as Fe	0.00	Nitrate as NO3	0.00
Manganese as Mn	0.00	Fluoride as F	0.00
*=as CaCO3		Sulfate as SO4	0

NOTE: .00 for Fe=<0.05; .00 for Mn=<0.03; .00 for NO3=<0.2

REPORTED BY: C. D. Fisher

C. D. FISHER

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ENVIRONMENTAL ENGINEERING LABORATORY

UNIVERSITY OF SASKATCHEWAN

DEPARTMENT OF CIVIL ENGINEERING

TO: Dr. M. D. Haug REPORTING DATE: May 1, 1989

SOURCE: AC 400 (0 psi) March 30, 1989 COLLECTION DATE: March 30, 1989

LAB NO: 30-3-896 ANALYSIS DATE: April 20, 1989

APPEARANCE: clear,colorless
ODOR: H2S
pH= 5.0

TOTAL DISSOLVED SOLIDS	mg/l	umhos/cm
By evaporation at 103°C	345,800	
By conductivity at 25°C	443,440	612,000

CATIONS	mg/l	ANIONS	mg/l
Total Hardness*	47,738	P. Alkalinity*	0
Calcium Hardness*	29,836	Carbonate as CO3	0
Magnesium Hardness*	17,902	Total Alkalinity*	14
Sodium as Na	99,455	Bicarbonate as HCO3	17
Potassium as K	4,376	Chloride as Cl	189,835
Iron as Fe	0.00	Nitrate as NO3	0.00
Manganese as Mn	0.00	Fluoride as F	0.00
*=as CaCO3		Sulfate as SO4	1,160

NOTE: .00 for Fe=<0.05; .00 for Mn=<0.03; .00 for NO3=<0.2

REPORTED BY: C. D. Fisher

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ENVIRONMENTAL ENGINEERING LABORATORY

UNIVERSITY OF SASKATCHEWAN

DEPARTMENT OF CIVIL ENGINEERING

TO: Dr. M. D. Haug REPORTING DATE: May 1, 1989

SOURCE: AV 100 (0 psi) March 30, 1989 COLLECTION DATE: March 30, 1989

LAB NO: 30-3-897 ANALYSIS DATE: April 20, 1989

APPEARANCE: clear,colorless
ODOR: H2S
pH= 2.3

TOTAL DISSOLVED SOLIDS	mg/l	umhos/cm
By evaporation at 103°C	340,000	
By conductivity at 25°C	434,000	600,000

CATIONS	mg/l	ANIONS	mg/l
Total Hardness*	41,273	P. Alkalinity*	0
Calcium Hardness*	28,186	Carbonate as CO3	0
Magnesium Hardness*	13,087	Total Alkalinity*	0
Sodium as Na	100,666	Bicarbonate as HCO3	0
Potassium as K	4,429	Chloride as Cl	187,552
Iron as Fe	0.00	Nitrate as NO3	0.00
Manganese as Mn	0.00	Fluoride as F	0.00
*=as CaCO3		Sulfate as SO4	655

NOTE: .00 for Fe=<0.05; .00 for Mn=<0.03; .00 for NO3=<0.2

REPORTED BY: C. D. Fisher

C. D. FISHER

ENVIRONMENTAL ENGINEERING LABORATORY

UNIVERSITY OF SASKATCHEWAN

DEPARTMENT OF CIVIL ENGINEERING

TO: Dr. M. D. Haug REPORTING DATE: May 1, 1989

SOURCE: Concrete (0 psi) March 30, 1989 COLLECTION DATE: March 30, 1989

LAB NO: 30-3-894 ANALYSIS DATE: April 20, 1989

APPEARANCE: clear,colorless
ODOR: H2S
pH= 11.3

TOTAL DISSOLVED SOLIDS	mg/l	umhos/cm
By evaporation at 103°C	333,600	
By conductivity at 25°C	449,200	620,000

CATIONS	mg/l	ANIONS	mg/l
Total Hardness*	25,594	P. Alkalinity*	56
Calcium Hardness*	24,571	Carbonate as CO3	15
Magnesium Hardness*	1,024	Total Alkalinity*	63
Sodium as Na	104,425	Bicarbonate as HCO3	10
Potassium as K	6,347	Chloride as Cl	184,415
Iron as Fe	0.00	Nitrate as NO3	0.00
Manganese as Mn	0.00	Fluoride as F	0.00
*=as CaCO3		Sulfate as SO4	80

NOTE: .00 for Fe=<0.05; .00 for Mn=<0.03; .00 for NO3=<0.2

REPORTED BY: C. D. Fisher

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DEPARTMENT OF CIVIL ENGINEERING

TO: Dr. M. D. Haug REPORTING DATE: May 1, 1989

SOURCE: Flyash (0 psi) March 30, 1989 COLLECTION DATE: March 30, 1989

LAB NO: 30-3-895 ANALYSIS DATE: April 20, 1989

APPEARANCE: clear,colorless
ODOR: H2S
pH= 10.2

TOTAL DISSOLVED SOLIDS	mg/l	umhos/cm
By evaporation at 103°C	330,800	
By conductivity at 25°C	449,200	620,000

CATIONS	mg/l	ANIONS	mg/l
Total Hardness*	24,464	P. Alkalinity*	94
Calcium Hardness*	22,425	Carbonate as CO3	22
Magnesium Hardness*	2,039	Total Alkalinity*	118
Sodium as Na	106,010	Bicarbonate as HCO3	28
Potassium as K	5,912	Chloride as Cl	185,220
Iron as Fe	0.00	Nitrate as NO3	0.00
Manganese as Mn	0.00	Fluoride as F	0.00
*=as CaCO3		Sulfate as SO4	566

NOTE: .00 for Fe=<0.05; .00 for Mn=<0.03; .00 for NO3=<0.2

REPORTED BY: C. D. Fisher

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UNIVERSITY OF SASKATCHEWAN

DEPARTMENT OF CIVIL ENGINEERING

TO: Dr. M. D. Haug REPORTING DATE: April 18, 1989

SOURCE: Brine, picked up March 22, 1989 COLLECTION DATE: March 29, 1989

LAB NO: 0329-892 ANALYSIS DATE: April 7, 1989

APPEARANCE: clear,colorless
ODOR: H2S
pH= 6.3

TOTAL DISSOLVED SOLIDS	mg/l	umhos/cm
By evaporation at 103°C	333,600	
By conductivity at 25°C	426,160	584,000

CATIONS	mg/l	ANIONS	mg/l
Total Hardness*	39,648	P. Alkalinity*	0
Calcium Hardness*	32,532	Carbonate as CO3	0
Magnesium Hardness*	7,116	Total Alkalinity*	18
Sodium as Na	95,562	Bicarbonate as HCO3	22
Potassium as K	4,473	Chloride as Cl	178,749
Iron as Fe	0.00	Nitrate as NO3	0.00
Manganese as Mn	0.00	Fluoride as F	0.00
*=as CaCO3		Sulfate as SO4	486

NOTE: .00 for Fe=<0.05; .00 for Mn=<0.03; .00 for NO3=<0.2

REPORTED BY: C. D. Fisher

C. D. FISHER

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UNIVERSITY OF SASKATCHEWAN

DEPARTMENT OF CIVIL ENGINEERING

TO: Dr. M. D. Haug REPORTING DATE: May 1, 1989

SOURCE: Pressure Tank #2 March 30, 1989 COLLECTION DATE: March 30, 1989

LAB NO: 30-3-891 ANALYSIS DATE: April 20, 1989

APPEARANCE: clear,colorless
ODOR: H2S
pH= 9.0

TOTAL DISSOLVED SOLIDS	mg/l	umhos/cm
By evaporation at 103°C	332,000	
By conductivity at 25°C	463,600	640,000

CATIONS	mg/l	ANIONS	mg/l
Total Hardness*	40,831	P. Alkalinity*	77
Calcium Hardness*	32,665	Carbonate as CO3	95
Magnesium Hardness*	8,166	Total Alkalinity*	185
Sodium as Na	104,118	Bicarbonate as HCO3	37
Potassium as K	5,920	Chloride as Cl	194,207
Iron as Fe	0.00	Nitrate as NO3	0.00
Manganese as Mn	0.00	Fluoride as F	0.00
*=as CaCO3		Sulfate as SO4	162

NOTE: .00 for Fe=<0.05; .00 for Mn=<0.03; .00 for NO3=<0.2

REPORTED BY: C. D. Fisher

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ENVIRONMENTAL ENGINEERING LABORATORY

UNIVERSITY OF SASKATCHEWAN

DEPARTMENT OF CIVIL ENGINEERING

TO: Dr. M. D. Haug REPORTING DATE: May 1, 1989

SOURCE: Pressure Tank #3 March 30, 1989 COLLECTION DATE: March 30, 1989

LAB NO: 30-3-892 ANALYSIS DATE: April 20, 1989

APPEARANCE: clear,colorless
ODOR: H2S
pH= 9.1

TOTAL DISSOLVED SOLIDS	mg/l	umhos/cm
By evaporation at 103°C	334,000	
By conductivity at 25°C	434,800	600,000

CATIONS	mg/l	ANIONS	mg/l
Total Hardness*	39,374	P. Alkalinity*	82
Calcium Hardness*	35,229	Carbonate as CO3	102
Magnesium Hardness*	4,145	Total Alkalinity*	168
Sodium as Na	97,398	Bicarbonate as HCO3	5
Potassium as K	4,974	Chloride as Cl	182,213
Iron as Fe	0.00	Nitrate as NO3	0.00
Manganese as Mn	0.00	Fluoride as F	0.00
*=as CaCO3		Sulfate as SO4	79

NOTE: .00 for Fe=<0.05; .00 for Mn=<0.03; .00 for NO3=<0.2

REPORTED BY: C. D. Fisher

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DEPARTMENT OF CIVIL ENGINEERING

TO: Dr. M. D. Haug REPORTING DATE: May 1, 1989

SOURCE: Pressure Tank #4 COLLECTION DATE: March 30, 1989
March 30, 1989
LAB NO: 30-3-893 ANALYSIS DATE: April 20, 1989

APPEARANCE: clear,colorless
ODOR: H2S
pH= 9.1

TOTAL DISSOLVED SOLIDS	mg/l	umhos/cm
By evaporation at 103°C	334,400	
By conductivity at 25°C	434,800	600,000

CATIONS	mg/l	ANIONS	mg/l
Total Hardness*	40,029	P. Alkalinity*	124
Calcium Hardness*	32,844	Carbonate as CO3	152
Magnesium Hardness*	7,185	Total Alkalinity*	269
Sodium as Na	98,532	Bicarbonate as HCO3	26
Potassium as K	4,721	Chloride as Cl	183,949
Iron as Fe	0.00	Nitrate as NO3	0.00
Manganese as Mn	0.00	Fluoride as F	0.00
*=as CaCO3		Sulfate as SO4	161

NOTE: .00 for Fe=<0.05; .00 for Mn=<0.03; .00 for NO3=<0.2

REPORTED BY: C. D. Fisher

C. D. FISHER

ENVIRONMENTAL ENGINEERING LABORATORY

UNIVERSITY OF SASKATCHEWAN

DEPARTMENT OF CIVIL ENGINEERING

TO: Dr. M. Haug REPORTING DATE: Feb. 4,1990

SOURCE: Tank #1 COLLECTION DATE: Dec. 2, 1989
Dec. 2, 1989
LAB NO: 120289M1 ANALYSIS DATE: Jan. 30, 1989

APPEARANCE: clear,colorless
ODOR: H2S
pH= 9.0

TOTAL DISSOLVED SOLIDS	mg/l	umhos/cm
By evaporation at 103°C	330,800	
By conductivity at 25°C	434,800	600,000

CATIONS	mg/l	ANIONS	mg/l
Total Hardness*	39,990	P. Alkalinity*	68
Calcium Hardness*	35,991	Carbonate as CO3	82
Magnesium Hardness*	3,999	Total Alkalinity*	136
Sodium as Na	89,978	Bicarbonate as HCO3	0
Potassium as K	3,999	Chloride as Cl	169,961
Iron as Fe	0.00	Nitrate as NO3	0.00
Manganese as Mn	0.00	Fluoride as F	0.00
*=as CaCO3		Sulfate as SO4	330

NOTE: .00 for Fe=<0.05; .00 for Mn=<0.03; .00 for NO3=<0.2

REPORTED BY:

C. D. FISHER

ENVIRONMENTAL ENGINEERING LABORATORY

UNIVERSITY OF SASKATCHEWAN

DEPARTMENT OF CIVIL ENGINEERING

TO: Dr. M. Haug REPORTING DATE: Feb. 4,1990

SOURCE: Tank #2 COLLECTION DATE: Dec. 2, 1989
Dec. 2, 1989
LAB NO: 120289M2 ANALYSIS DATE: Jan. 30, 1989

APPEARANCE: clear,colorless
ODOR: H2S
pH= 8.4

TOTAL DISSOLVED SOLIDS	mg/l	umhos/cm
By evaporation at 103°C	332,200	
By conductivity at 25°C	437,600	604,000

CATIONS	mg/l	ANIONS	mg/l
Total Hardness*	40,710	P. Alkalinity*	35
Calcium Hardness*	35,745	Carbonate as CO3	42
Magnesium Hardness*	4,965	Total Alkalinity*	112
Sodium as Na	90,356	Bicarbonate as HCO3	50
Potassium as K	3,872	Chloride as Cl	171,130
Iron as Fe	0.00	Nitrate as NO3	0.00
Manganese as Mn	0.00	Fluoride as F	0.00
*=as CaCO3		Sulfate as SO4	83

NOTE: .00 for Fe=<0.05; .00 for Mn=<0.03; .00 for NO3=<0.2

REPORTED BY:

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ENVIRONMENTAL ENGINEERING LABORATORY

UNIVERSITY OF SASKATCHEWAN

DEPARTMENT OF CIVIL ENGINEERING

TO: Dr. M. Haug REPORTING DATE: Feb. 4,1990

SOURCE: Tank #3 COLLECTION DATE: Dec. 3, 1989
Dec. 2, 1989
LAB NO: 120389M1 ANALYSIS DATE: Jan. 30, 1989

APPEARANCE: clear,colorless
ODOR: H2S
pH= 8.7

TOTAL DISSOLVED SOLIDS	mg/l	umhos/cm
By evaporation at 103°C	334,000	
By conductivity at 25°C	434,800	600,000

CATIONS	mg/l	ANIONS	mg/l
Total Hardness*	41,416	P. Alkalinity*	73
Calcium Hardness*	37,472	Carbonate as CO3	86
Magnesium Hardness*	3,944	Total Alkalinity*	156
Sodium as Na	90,721	Bicarbonate as HCO3	12
Potassium as K	4,142	Chloride as Cl	172,316
Iron as Fe	0.00	Nitrate as NO3	0.00
Manganese as Mn	0.00	Fluoride as F	0.00
*=as CaCO3		Sulfate as SO4	167

NOTE: .00 for Fe=<0.05; .00 for Mn=<0.03; .00 for NO3=<0.2

REPORTED BY:

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ENVIRONMENTAL ENGINEERING LABORATORY

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DEPARTMENT OF CIVIL ENGINEERING

TO: Dr. M. Haug REPORTING DATE: Feb. 4,1990

SOURCE: Tank #4 Dec. 2, 1989 COLLECTION DATE: Dec. 3, 1989

LAB NO: 120389M2 ANALYSIS DATE: Jan. 30, 1989

APPEARANCE: clear,colorless
ODOR: H2S
pH= 8.9

TOTAL DISSOLVED SOLIDS	mg/l	umhos/cm
By evaporation at 103°C	332,000	
By conductivity at 25°C	437,600	604,000

CATIONS	mg/l	ANIONS	mg/l
Total Hardness*	39,811	P. Alkalinity*	62
Calcium Hardness*	35,829	Carbonate as CO3	74
Magnesium Hardness*	3,981	Total Alkalinity*	125
Sodium as Na	90,569	Bicarbonate as HCO3	0
Potassium as K	3,981	Chloride as Cl	170,729
Iron as Fe	0.00	Nitrate as NO3	0.00
Manganese as Mn	0.00	Fluoride as F	0.00
*=as CaCO3		Sulfate as SO4	332

NOTE: .00 for Fe=<0.05; .00 for Mn=<0.03; .00 for NO3=<0.2

REPORTED BY:

C. D. FISHER

ENVIRONMENTAL ENGINEERING LABORATORY

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DEPARTMENT OF CIVIL ENGINEERING

TO: Dr. M. D. Haug REPORTING DATE: April 18, 1989

SOURCE: Concrete
0 psi
COLLECTION DATE: Dec. 2, 1989

LAB NO: 0319901 ANALYSIS DATE: March 11, 1990

APPEARANCE: clear, colorless
ODOR: H2S
pH= 8.8

TOTAL DISSOLVED SOLIDS	mg/l	umhos/cm
By evaporation at 103°C	341,200	
By conductivity at 25°C	434,800	600,000

CATIONS	mg/l	ANIONS	mg/l
Total Hardness*	44,331	P. Alkalinity*	45
Calcium Hardness*	38,286	Carbonate as CO3	54
Magnesium Hardness*	6,045	Total Alkalinity*	89
Sodium as Na	92,693	Bicarbonate as HCO3	0
Potassium as K	4,635	Chloride as Cl	178,020
Iron as Fe	0.00	Nitrate as NO3	0.00
Manganese as Mn	0.00	Fluoride as F	0.00
*=as CaCO3		Sulfate as SO4	81

NOTE: .00 for Fe=<0.05; .00 for Mn=<0.03; .00 for NO3=<0.2

REPORTED BY:

C. D. FISHER

ENVIRONMENTAL ENGINEERING LABORATORY

UNIVERSITY OF SASKATCHEWAN

DEPARTMENT OF CIVIL ENGINEERING

TO: Dr. M. D. Haug REPORTING DATE: April 18, 1989

SOURCE: Flyash 0 psi COLLECTION DATE: Dec. 2, 1989

LAB NO: 0319902 ANALYSIS DATE: March 11, 1990

APPEARANCE: clear, colorless
ODOR: H2S
pH= 7.3

TOTAL DISSOLVED SOLIDS	mg/l	umhos/cm
By evaporation at 103°C	346,400	
By conductivity at 25°C	437,600	604,000

CATIONS	mg/l	ANIONS	mg/l
Total Hardness*	44,142	P. Alkalinity*	0
Calcium Hardness*	40,129	Carbonate as CO3	0
Magnesium Hardness*	4,013	Total Alkalinity*	58
Sodium as Na	93,300	Bicarbonate as HCO3	71
Potassium as K	4,515	Chloride as Cl	178,783
Iron as Fe	0.00	Nitrate as NO3	0.00
Manganese as Mn	0.00	Fluoride as F	0.00
*=as CaCO3		Sulfate as SO4	0

NOTE: .00 for Fe=<0.05; .00 for Mn=<0.03; .00 for NO3=<0.2

REPORTED BY:

C. D. FISHER

ENVIRONMENTAL ENGINEERING LABORATORY

UNIVERSITY OF SASKATCHEWAN

DEPARTMENT OF CIVIL ENGINEERING

TO: Dr. M. D. Haug REPORTING DATE: April 18, 1989

SOURCE: AV100 COLLECTION DATE: Dec. 2, 1989
0 psi
LAB NO: 0319903 ANALYSIS DATE: March 11, 1990

APPEARANCE: clear, colorless
ODOR: H2S
pH= 5.7

TOTAL DISSOLVED SOLIDS	mg/l	umhos/cm
By evaporation at 103°C	343,000	
By conductivity at 25°C	434,800	600,000

CATIONS	mg/l	ANIONS	mg/l
Total Hardness*	44,435	P. Alkalinity*	0
Calcium Hardness*	30,297	Carbonate as CO3	0
Magnesium Hardness*	14,138	Total Alkalinity*	8
Sodium as Na	92,404	Bicarbonate as HCO3	10
Potassium as K	4,645	Chloride as Cl	177,604
Iron as Fe	0.00	Nitrate as NO3	0.00
Manganese as Mn	0.00	Fluoride as F	0.00
*=as CaCO3		Sulfate as SO4	245

NOTE: .00 for Fe=<0.05; .00 for Mn=<0.03; .00 for NO3=<0.2

REPORTED BY:

C. D. FISHER

ENVIRONMENTAL ENGINEERING LABORATORY

UNIVERSITY OF SASKATCHEWAN

DEPARTMENT OF CIVIL ENGINEERING

TO: Dr. M. D. Haug REPORTING DATE: April 18, 1989

SOURCE: AC400
0 psi
COLLECTION DATE: Dec. 2, 1989

LAB NO: 0319904
ANALYSIS DATE: March 11, 1990

APPEARANCE: clear, colorless
ODOR: H2S
pH= 4.2

TOTAL DISSOLVED SOLIDS	mg/l	umhos/cm
By evaporation at 103°C	344,200	
By conductivity at 25°C	434,800	600,000

CATIONS	mg/l	ANIONS	mg/l
Total Hardness*	46,606	P. Alkalinity*	0
Calcium Hardness*	30,395	Carbonate as CO3	0
Magnesium Hardness*	16,211	Total Alkalinity*	0
Sodium as Na	91,185	Bicarbonate as HCO3	0
Potassium as K	4,357	Chloride as Cl	177,029
Iron as Fe	0.00	Nitrate as NO3	0.00
Manganese as Mn	0.00	Fluoride as F	0.00
*=as CaCO3		Sulfate as SO4	244

NOTE: .00 for Fe=<0.05; .00 for Mn=<0.03; .00 for NO3=<0.2

REPORTED BY:

C. D. FISHER

ENVIRONMENTAL ENGINEERING LABORATORY

UNIVERSITY OF SASKATCHEWAN

DEPARTMENT OF CIVIL ENGINEERING

TO: Dr. M. Haug REPORTING DATE: Feb. 4,1990

SOURCE: Tank #1 Dec. 2, 1989 COLLECTION DATE: Dec. 2, 1989

LAB NO: 120289M1 ANALYSIS DATE: Jan. 30, 1989

APPEARANCE: clear,colorless
ODOR: H2S
pH= 9.0

TOTAL DISSOLVED SOLIDS	mg/l	umhos/cm
By evaporation at 103°C	330,800	
By conductivity at 25°C	434,800	600,000

CATIONS	mg/l	ANIONS	mg/l
Total Hardness*	39,990	P. Alkalinity*	68
Calcium Hardness*	35,991	Carbonate as CO3	82
Magnesium Hardness*	3,999	Total Alkalinity*	136
Sodium as Na	89,978	Bicarbonate as HCO3	0
Potassium as K	3,999	Chloride as Cl	169,961
Iron as Fe	0.00	Nitrate as NO3	0.00
Manganese as Mn	0.00	Fluoride as F	0.00
*=as CaCO3		Sulfate as SO4	330

NOTE: .00 for Fe=<0.05; .00 for Mn=<0.03; .00 for NO3=<0.2

REPORTED BY:

C. D. FISHER